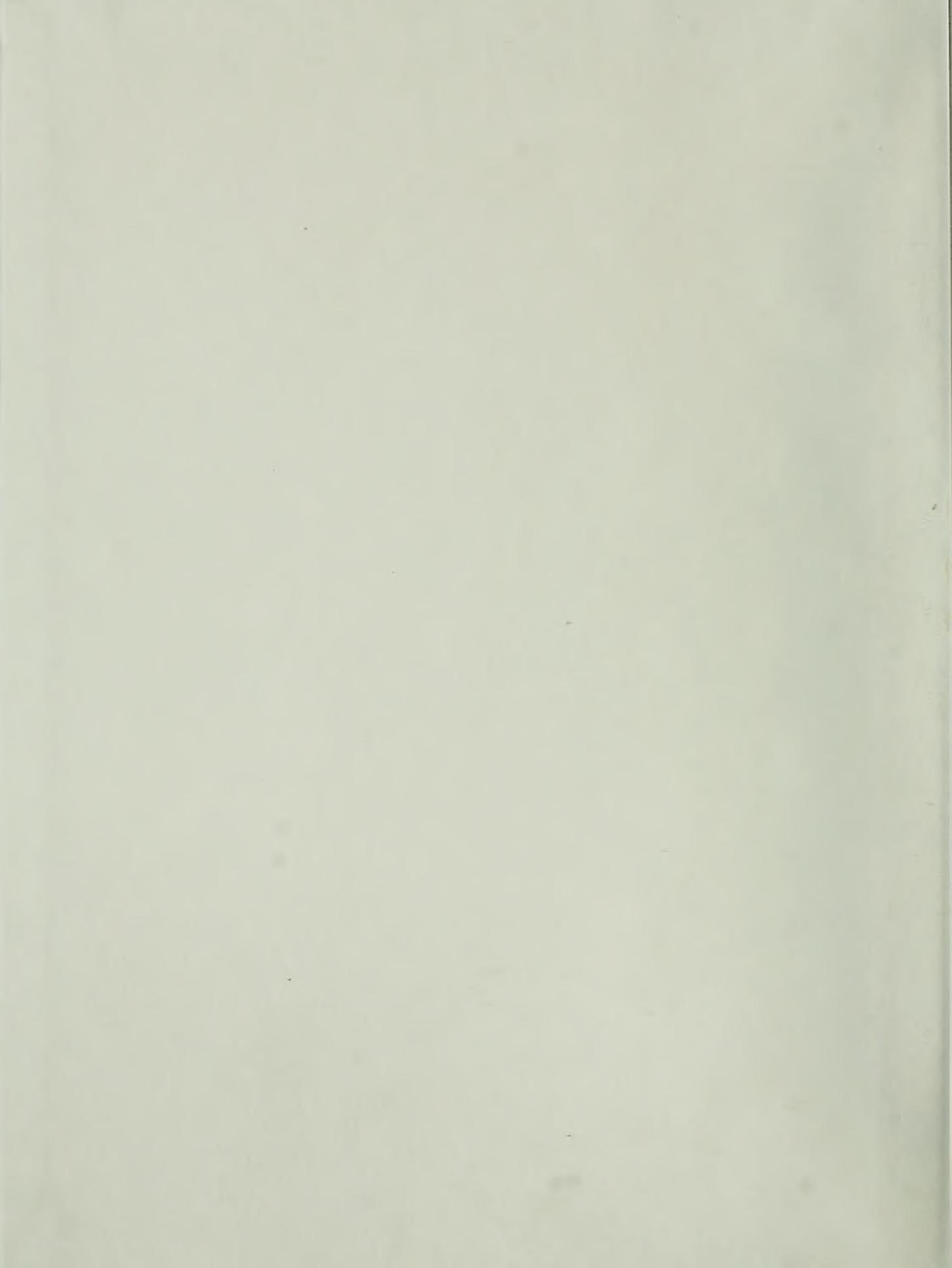


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**Universal Dictionary**

OF

**ARTS, SCIENCES, AND LITERATURE.**

**VOL. XIII.**

THE

ENCYCLOPEDIA;

THEORETICAL AND PRACTICAL

OF THE ARTS AND SCIENCES

VOL. VIII.

THE  
CYCLOPÆDIA;

OR,

UNIVERSAL DICTIONARY

OF

Arts, Sciences, and Literature.

BY

ABRAHAM REES, D.D. F.R.S. F.L.S. *S. Amer. Soc.*

WITH THE ASSISTANCE OF  
EMINENT PROFESSIONAL GENTLEMEN.

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IN THIRTY-NINE VOLUMES.  
VOL. XIII.

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LONDON:

PRINTED FOR LONGMAN, HURST, REES, ORME, & BROWN, PATERNOSTER-ROW,  
F. C. AND J. RIVINGTON, A. STRAHAN, PAYNE AND FOSS, SCATCHERD AND LETTERMAN, J. CUTHELL,  
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1819.

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## ELOCUTION.

**E**LOCUTION is a term which, according to the strictness of etymological definition, might be applied to signify every thing that is included in the faculty and utterance of thought, by the means of language, whether oral or written; and some writers, even in modern times, have applied it, with more attention apparently to derivation than to authorized precision and necessary contradistinction, to written composition as well as to actual speech. At the same time, two other terms, oratory and eloquence, (which etymological refinement might undoubtedly reduce to the same original signification,) have admittance and current usage in our language, and are occasionally used as synonyms of elocution in our looser conversation. But every copious subject, when it comes to be treated in a didactic way, requires more terms of settled distinction than the simplicity of rigid etymology can be expected to furnish; and "many terms which, in the laxity of general conversation, are indifferently and indistinctly used, in the precision of scientific discussion must be carefully separated and placed in contradistinction: the very admission of synonyms being perfectly inconsistent with the progress and comprehension of scientific truth."

These three terms, therefore, in the very outset of the present subject, should be clearly and distinctly defined, and the boundaries of signification assignable to each, as terms of contradistinction, be precisely marked. This has accordingly been done by a popular lecturer of the present day. "Eloquence," says he, "may be defined, 'the art of expressing our thoughts and feelings with precision, force, and elegance; and of heightening the impressions of reason by the colourings of imagination.'" It is applicable, therefore, to the whole faculty of verbal discourse, whether oral or written. It addresses itself by the pen, to the eye, as well as by the living organs to the ear. Thus we speak (with ad-

mitted accuracy) of an eloquent book, as freely as of an eloquent oration; of the eloquent Buffon (alluding to his celebrated work upon natural history); and of the eloquent writings, as well as the eloquent speeches of Edmund Burke. The Apoptrophe to the queen of France, is as genuine a piece of eloquence as if it had been spoken in the house of commons.

Oratory, on the contrary, is precise and limited in its application: and, in this respect, indeed, even popular usage is pretty generally correct. It may be defined, "oral eloquence; or the art of communicating, by the immediate action of the vocal and expressive organs, to popular, or to select assemblies, the dictates of our reason, or our will, and the workings of our passions, our feelings, and our imaginations." Oratory, therefore, includes the idea of eloquence: for no man can be an orator who hath not an affluence of thought and language. But eloquence does not necessarily include the idea of oratory; since a man may be rich in all the stores of language and of thought, without possessing the advantages of a graceful and impressive delivery. It is, therefore, the name of a more complex idea; and includes, besides the general notion of eloquence, the practical part of elocution: which being our immediate object, must be spoken of more at large. "Elocution may be regarded either as a science, or as an act. In the former case it may be defined, 'the science by which the rules for the just delivery of eloquence are taught;'" in the latter, "the happy combination and coincidence of vocal, enunciative, and gestulative expression, by which oratorical excitement is super-added to the eloquence of thought and language." In other words: "Elocution is the art, or the act of so delivering our own thoughts and sentiments, or the thoughts and sentiments of others, as not only to convey to those around us (with precision, force, and harmony) the full purport

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purport and meaning of the words and sentences in which those thoughts are clothed; but, also, to excite and impress upon their minds, the feelings, the imaginations, and the passions, by which those thoughts are dictated, or with which they should naturally be accompanied."

"Elocution, therefore, in its more ample and liberal signification, is not confined to the mere exercise of the organs of speech. It embraces the whole theory and practice of the exterior demonstration of the inward workings of the mind." In short, "eloquence may be considered as the soul, or animating principle of discourse; and is dependent on intellectual energy and intellectual attainments. Elocution is the embodying form, or representative power; dependent on exterior accomplishment, and cultivation of the organs. Oratory is the complicated and vital existence resulting from the perfect harmony and combination of the two."

The object, then, of the science of elocution is the improvement of oral language, as contradistinguished from mere graphic composition; and the cultivation of every external grace and accomplishment with which the delivery of language should be accompanied, whether in reading, in recitation, or in spontaneous utterance: an object, to the attainment of which the ancients devoted a very considerable portion of attention; and for the due comprehension of which, it appears to be necessary to go somewhat deeper in our researches into the physical and moral powers of man, than has been suspected by the generality of modern professors; and instead of calling in question, as some recent cavillers have done, whether elocution is even to be regarded as an art, to establish its doctrines on the settled principles of science, and demonstrate the essential elements of that science as a branch of natural philosophy. To the want of this due consideration of the subject, and to the incongruous maxims relative to it, are perhaps to be attributed not only the frequency of every species of disgusting impediment in modern speech, but the lame and impotent state of public speaking among us, when compared in its effects with the splendid and impressive oratory of ancient times. "In those parts of oratory, indeed, which relate to the arrangements of thought, and the energies of expressive language, there is no deficiency of existing models; and, certainly, no paucity whatever of pedantic rules and treatises. Cicero and Demosthenes still continue to speak to the eye, in all the eloquence of graphic words; and Quintilian and Blair (like two conspicuous luminaries, in the ancient and modern hemispheres of oratorical criticism) illumine the tracks of written language, and may help to inform us how orations should be composed. In this part of oratory, the present and the preceding generation have, accordingly, something to boast. But for the theory and practice of those impressive exterior demonstrations with which the delivery of such orations should be accompanied, to what systems, or to what models can the English student appeal? In short, eloquence has been cultivated among us with considerable diligence; but elocution has been so much neglected, that the very nature of the science seems to be entirely forgotten; and the few fragments of antiquity that have descended to us upon the subject, are evidently misunderstood by those who have pretended to comment upon them; and many of our most learned critics have either ingenuously acknowledged, or unwarily betrayed, their total inability to comprehend some of those very distinctions most indispensable to the expression and harmony of oratorical delivery: such, for example, as the musical accents of speech, or inflections of the voice in the harmonic scale; the proportions of respondent sounds

and cadences, and the essential contradistinctions of percussion, accent, and quantity."

Such is the language of the lecturer already quoted; who, to rescue the elements of elocution from this state of neglect and chaos, and to facilitate the general attainment of an accomplishment so generally desirable, proceeds, in his "Introductory Discourse," thus cursorily to state the extent and nature of the subject.

"Elocution," says he, "is, 1. Partly a science, founded on ascertainable principles, and susceptible of palpable demonstrations; 2. Partly an art, attainable by imitative application and observance; and subject to such laws as result from comparison of general principles with practical experience; and, 3. Partly an object of taste and sentiment, dependent on acuteness of perception, and delicacy and refinement of feeling.

1. "As a science its foundations are to be sought, 1st. In physiology; that is to say, in the anatomical structure of the elocutionary organs, and the laws of physical necessity, by which their actions and reactions are directed and circumscribed: some knowledge of which seems to be indispensably requisite to the complete development and exertion of their respective powers; to the supply of accidental and occasional deficiencies; and to the correction of those erroneous and defective modes of utterance, which, originating in negligent or vicious imitation, have ripened into habitual impediments. 2d. In music, the essential laws and accidents of which, with only one conspicuous exception;" the progress of the tune, in one instance, being by slides or accidental inflections, "lifting the voice up and down in the musical scale;" and in the other, by ascertainable intervals and perceptible gradations; "are as applicable to elocution as to song: all fluent and harmonious speech (even that of the most easy and familiar conversation) as necessarily and as absolutely falling into the rythmical division of musical bars, and into the two generic measures of common and of triple time, as the warblings of the most scientific singer on the stage; while several of the impediments which most seriously obstruct and deform the elocution of injudicious speakers, may be proved to originate in no other cause than the violation of these musical principles, and the consequent resistance of those physical necessities which limit the facilities of organic action, and with which the elementary principles of harmonic proportion so admirably and so mysteriously conform. 3d. In philology, also, elocution hath a basis, inasmuch as to the philology of the structure and composition of language, and to the acute researches of the etymologist, many of those disputed questions of pronunciation, quantity, and percussive accent, which have hitherto been surrendered to the arbitrary and fluctuating decisions of fashion, ought, in reality, to be referred."

To which might have been added that the time of speech itself, is, or ought to be, a result of philological perception: the quantities, emphases, and inflections of syllables, in all perfect speech, being dictated by the sense and import of such syllables; either inherent in their original structure and individual signification, or derivable from sentiment and association.

2. As an art, the laws of elocution are partly grammatical, as arising out of the structure and arrangement of sentences, and the consequent degrees of connection and relationship between the different words and members and portions of the discourse to be pronounced; partly harmonic, as connected with the practical regulation of the variations and proportions of harmonic sound, with which such discourse should be accompanied; and partly mechanical, or experimental,

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mental, as relating to the motions and positions of the respective organs, by which the varieties of vocal and enunciative expression are produced.

3. As a matter of taste, elocution embraces the consideration of such peculiar habits of study, deportment, and association, as are favourable to acuteness and delicacy of susceptibility, both in the intellectual and the organic system, and give them their peculiar bias and direction. In this point of view, all the finer arts, and all the more intellectual accomplishments constitute essential parts of the studies of the finished elocutionist. He should have an *eye* for the glowing tints and flowing lines of picture, the proportions of architecture and the symmetries of statuary; an *ear* for the ravishing delights of music; a *perception* of the vital graces of look and attitude and motion, far beyond all that the dancing school and the opera house can teach; and a *soul* tremblingly alive to all the enthusiasm of poetry, and all the poignancy of sentiment and pathos.

In vindication of the claim of this science to such an ample field of illustration and accomplishment, an appeal may be made from modern maxims to the example of classical antiquity, to the facts that stand upon record, and the relics of ancient criticism that yet remain: for although much in the outset of the inquiry appeared to the lecturer in the light of original discovery, further investigation, we are informed, "convinced him, that many of those doctrines, which he imagined to be new, are only "restitutions of decayed intelligence;" and what has, in reality, been added to the treasures that well-directed labours might have redeemed from the overwhelmed ruins of classical criticism, is probably confined to the physiological parts of the subject, and the connection attempted to be traced between the primary laws of physical action and re-action, and the elements of musical proportion."

These, however, constitute a very essential portion of the science of elocution; and the student of that science must begin, in the first instance, by investigating the structure and offices of those organs upon which the functions of speech depend, which will be found to consist of two distinct classes, the separate actions and attributes of which, it is highly important that the professor at least should accurately comprehend, lest by mistaking the source of the defects to be removed, he should necessarily fail in the application of the remedy. These are, 1, the vocal organs, or those portions of the organic system employed by the human (or other animated) being in the production and variation of expressive sounds; and, 2, the enunciative organs, which, in the complication and perfection of their structure, are peculiar to man, and are employed in superadding to the sounds of voice, certain other specific impulses, constituting thereby the elements and syllables out of which are composed the whole mechanism of human language.

When, however, these two classes of organs are said to be distinct, that word is not to be understood in so absolute a sense, as to preclude the supposition of some of them discharging the two-fold office of modifying the tone and superadding the specific quality of literal element. The nostrils, for example, which constitute a very essential part of the complicated organization that gives character to individual voices, are the chief implement employed in forming the elementary sounds of *n*, *ng*, &c. while the teeth, and some other parts of the mouth, principally employed in the formation of the characteristic elements, have, also, a material operation in modifying the tone of the voice. The practical distinction is, however, sufficiently evinced, by the separate manifestation of their effects: the tones and inflexions of voice being exhibited in the most exquisite perfection by

several species of singing birds, who are destitute of the organization requisite for speech, and speech itself being capable of proceeding, in the human subject, in forcible whispers, that is to say, by the action of the enunciative organs on a mere stream of breath, without accompaniment of any tone, or sound of voice. Of this, however, more hereafter. See VOICE, ENUNCIATION, ORGANS OF SPEECH, &c.

From the structure of the organs, the physiological enquirer is next conducted to a consideration of the laws of physical necessity, under which the functions of these respective organs are performed; and the mode of operation by which volition accommodates itself to the restrictions inevitably imposed: an investigation which involves several topics of considerable curiosity. From the simple principle of pendulation (the primary and indispensable law of all reiterated action) are explained many of the essential phenomena of enunciative and vocal expression, as the trill of the R; the impracticability of reiterating identical elements, or pronouncing, in immediate succession, certain elements closely approximating in organic formation, without intervening pauses; the facilities of certain combinations of element, the difficulty of others, and, consequently, the physical causes of euphony and cacophony; (see EUPHONY, &c.) and, above all, the nature and causes of those radical differences in the qualities of successive syllables so well understood (in practice, and essence at least, if not in cause,) by the grammarians of Greece, and designated by them under the terms *thesis* and *arsis*, but the total inapprehension of which has been the cause of so much confusion in the theories and embarrassment in the practical instructions of modern professors. The leading dogmas of this system are so self-evident, their application to organic as well as mechanic motion, and to the actions of the organs of speech in particular, so demonstrable, and the coincidence of these actions with the phenomena of a certain alternate energy and remission in the process of verbal utterance so apparent, that it is only astonishing how the principle itself should have remained so long obscured. But there is still room enough in the world of scientific discovery for other Columbuses to crack the heavy end of other eggs. But our business is an abstract, not a declamation. Thus then, it is contended, that action is of two kinds, continuous, or proceeding for a certain space of time, in a certain direction, from one original impulse, as the flight of a dart by the impulse of the bow, or of a ball from the explosion of a cannon, &c.; or reiterated and capable of unlimited continuity, from successive impulse, as in the pendulum of a clock, the motion of the legs in walking, &c. But speech is not a continuous action proceeding for a certain space in a certain direction from one original impulse, like the flight of a dart, &c. but a series of reiterated actions like those of the pendulum, or of walking, &c. though much more complicated and diversified by variety of phenomena, and, for that end, by necessary modification of impulse. Still, however, speech is action, reiterated action, resulting from reiterated impulse, and consequently subject to the indispensable law of reiteration, namely, re-action, or alternation; for as the pendulum when it has made its full swing in one direction must re-act in the opposite direction, before the primary action can be repeated; and as when one of the lower extremities has been advanced at full stride before the body it must either be drawn back again towards its former position, or, by a more complicated pendulation, the body must advance upon the limb, and thus restore the original poise to give the other extremity an opportunity of similar action, before the leg first advanced can advance again; so when the tongue, lip, or uvula have acted in any given direction for the formation of

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any given element, it must re-act silently or expressively either upon the primary, or in some new direction, before the same element can be repeated, or any other element, requiring a similar line of action can be formed. And so, also, when the primary organ of cadential or syllabic impulse (the cartilage that surrounds the larynx) has been once contracted for the impulsion of the more energetic note, a re-action of that organ, either silent or accompanied by another note of less energy, must take place before the contractile energy can be renewed. Hence are derivable all the phenomena that belong to, or are to be described under the denominations of *cadence, measure, rhythmus, metrical feet*, and other distinctions arising out of those radical and essential differences in the qualities of syllables, sometimes described by the terms *accented and unaccented*, and sometimes by the very same writers, in the very same page, denied the distinction of accentuation; and sometimes, also, confounded with the quantities, and by the denominations, of *long and short*, but with which most certainly, neither accent nor quantity have any thing whatever to do. (See ACCENT, MEASURE, RHYTHMUS, PROSODY, METRICAL FEET, QUANTITY, &c. See, also, POISE, THESIS, and ARSIS, PULSATION, and REMISSION, &c.) Hence, also, will be found derivable (not from caprice, or taste, or arbitrary invention, but from physical principles) the distribution of all vocal melodies (and thence by imitation of all other melodies) into the proportions and cadences of common and of triple time; (see TIME,) and hence some light perhaps may be thrown upon that curious and hitherto unfathomable question, the cause of the exclusive satisfaction received by the human ear from sounds that follow each other in those definite and simple proportions.

Having laid these foundations of theory on the solid basis of experiment, the elocutionary physiologist may proceed to practice, and the crown and pinnacle of his labours consist in the exposition of the nature and causes of the various impediments and imperfections of speech; and in the application of the proper remedies applicable to those defects, whether originating in organic deficiencies, or malconformations; or adopted from imitation, confirmed by the inveteracy of erroneous habit. (See IMPEDIMENT.) The practical part of elocution also necessarily includes all that relates to the education and management of the organs of speech; the improvement of the expressive powers of voice and enunciation; the laws of inflection, proportion and harmony; and the graces and accomplishments with which the delivery of speech (whether original or imitative) should naturally be accompanied; and by which its effects upon the heart, the judgment and the imagination may be heightened and confirmed. See PHYSIOGNOMICAL EXPRESSION, GESTICULATION, &c.

Such is the general outline of the science of elocution, according to the only professor of modern times, by whom the subject has ever been treated in a scientific point of view, and from the notes of whose public lectures this abstract is principally furnished; a science which, however neglected, deserves (for its practical application at once to the noblest purposes of public exertion, and the most familiar gratifications of private life,) a considerable portion of the attention of those who are entrusted with the education of youth. For if oratorical excellence be an object only to the few, yet that those few should have the means of cultivating those parts of such excellence which appear to be within reach of systematic tuition, is certainly highly desirable; and (not to dwell upon the consideration that it is not always practicable to foresee, during the season of early tuition, who shall, or who shall not, be among the number of that few to whom such accom-

plishment might be of primary importance) "some degree, at least, of elocutionary accomplishment is certainly desirable by all. There are few, indeed, to whom it would not be advantageous (at least in point of mental gratification) to be able to read, with emphasis and harmony, the fine passages of our poets, or the instructive and elegant compositions of our historians, moralists, and amusive writers:— There is, perhaps, scarcely any individual who has not, occasionally, experienced the advantage of delivering what he had to say with correctness, ease, and impressiveness; or (lacking this accomplishment) who has not felt the disadvantages resulting from such defect. Even in the social intercourses of private life, how great are the benefits of this attainment! How does it multiply the sources of innocent pleasure! What a zest does it impart to the highest, though most familiar, of our intellectual gratifications!"

"Fortunately for mankind," continues Mr. Thelwall, "this accomplishment, so universally, to be desired, needs never to be desired in vain. With those exceptions only, which result from deafness, or from mental imbecility, I shall, I think, demonstrate, that (by no greater sacrifice of time and effort than is usually devoted to less important sciences and much more frivolous accomplishments) correct and impressive elocution is attainable by all." He admits, however, "that hitherto, at least, the instances of such attainment have been exceedingly rare; that few are the Englishmen who converse with fluency and impressive grace; and fewer still who can read with tolerable harmony and propriety. Even in our churches, the sublimest passages lose their impressiveness from the imperfect manner in which they are delivered; and those very preachers who are most accomplished in every other particular, too frequently obscure, by the wretchedness of their elocution, the eloquent discourses they compose.

"But the causes of this it is not difficult to discover. We trace them, at once, in the almost universal neglect of this important branch of education. Even of the professed teachers, in this department, where is the individual who has properly explored the extent, or the principles of the science, or who has even suspected that science had any thing to do with the subject? It has almost been questioned whether elocution were even an art? Excellence has been regarded as the mere mysterious gift of nature or of fortune—as the original and unsolicited dispensation of a partial providence; which no education could secure, and which study and application were scarcely necessary to improve. With respect to the constituents of that excellence, mere taste and presentment have been regarded as the only arbiters; the very laws of inflection and proportion have been denied all foundation and existence in the utterance of modern speech; and pronunciation, tone, and melody, and even the constituent requisite of percussive accent, (upon which the individuality, the character and the force of spoken words essentially depend,) have been abandoned to the lawless rule of fashion and caprice." Introductory Discourse on the Nature and Objects of Elocutionary Science.

Elocution has by many been considered as contradistinguishable into three several kinds, reading, recitation, and spontaneous speech; and some professors have marked these distinctions so absolutely, as to prescribe different styles of utterance, both in vocal and enunciative expression, to the reader and the reciter, from those which they regard as belonging to the unpremeditative speaker. Mr. Cockin, in particular, in an ingenious dissertation (published without his name, 1775) on "The Art of Delivering written Language," has maintained this hypothesis; and has discussed the subject of these supposed differences under the respective

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ize heads of accent, emphasis, modulation, expression, (of voice as well as gesture,) and pauses; for the latter four of which, see hereafter under their respective titles. This work, we are informed in the dedication, was altogether approved by Mr. Garrick, who assured the author "that the doctrine laid down in that essay agreed exactly with his own sentiments." The popular axiom, however, "read exactly as you would speak," (supposing it addressed to a good speaker,) seems, in its principle, to be a rule much more rational than any thing that even the ingenuity of Mr. Cocker, though applauded by Mr. Garrick, has been able to adduce. It is objectionable, indeed, on account of its impracticability; pointing out a degree of perfection that was never yet attained, nor ever will be, till perfection in other arts and accomplishments shall be attained also. But the principle is not, therefore, the less valuable; the models of perfection must not be discarded from our minds, because art could never yet completely realize them: and although there are impediments, perhaps insurmountable, in the way of giving either to reading or recitation all the ease, the grace, and the vitality of spontaneous speech, yet, in principle, they should assuredly be the same; for reading and recitation are only two different modes of imitating that nature, which spontaneous speaking exhibits in her original reality; and the imitation ought to be so much the more perfect and exact, as, in this instance, the artist has the exclusive advantage of operating not only on the model, but with the very materials which nature herself employs in her creations. Mr. C., however, contends, "that reading does not receive any of its beauties from the principles of imitation, being no copy, but only another kind of speech." That, generally speaking, it is so, cannot be denied: but it is so far from unquestionable that it ought to be so, that this may be perhaps assigned as the genuine reason why the *reading* even of those very persons produces only sleep, whose unpremeditated *speaking*, is the delight of all ears; and why lectures never interest the auditors, like spontaneous harangues.

There are, however, certain particulars of essential distinction in the practical facilities; and even capabilities of excellence, in reading, recitation, and original speech, which the student of elocution ought to understand, as thereby each may perhaps be brought somewhat nearer to perfection than can be expected without the due consideration of these circumstances. Thus, for example, spontaneous speech, springing immediately from the inspiration of feeling, with all the freshness and glow of original conception, is capable of a degree of warmth, ease, and flowing energy, which can belong only to first impressions and unpremeditated language. From this very circumstance, however, it is incapable of all the smoothness, proportion, and harmony, which a minute attention to euphony, construction, rhythmus, and quantity, may enable the reader and reciter to accomplish. The reader, on the contrary, who finds the language ready polished to his hands, and sees it spread out before him, has leisure for full attention to all the minutiae of rhythmical cadence; and if his ear be good, his perceptions acute, and his notions of the principles of elocutionary harmony correct, he may certainly attain a degree of perfection of utterance, in what relates to mere proportion and melody, which none but the reader must expect. But then, on the other hand, the reader (especially he who reads at sight; and if he has previously studied, he becomes, in a certain degree, a *reciter*), pronounces what he reads, not with the feelings of an originator, or imparter, but with the feelings of a recipient; his mind is passive while his organs only are active: hence, inevitably, a certain degree of coldness and unnatural restraint.

The reciter partakes of the advantages and disadvantages of both; and he has both advantages and disadvantages peculiar to himself. If what he should repeat be completely in his memory, he makes it, to a certain degree, his own, and may approximate to the ease of the spontaneous speaker, and the smooth melody of the accomplished reader, though he can never completely attain the unsophisticated warmth and vitality of the former, or the complete rhythmus and nicely measured pauses of the latter. At the same time, by repeated experiment, he may have adjusted his tones and attitudes, and the expressions of his countenance, more completely to the sentiment and passion of the passages he is to deliver than the reader could possibly have done, and have accommodated them more completely to the rules and principles of grace, than is practicable to the spontaneous speaker: but what he gains in force and propriety he is in danger of losing in simplicity; and the mere reciter, however excellent, is more likely to extort applause than to awaken the genuine sympathies of the soul. From this view of the subject, the lecturer already cited concludes, that though the principles of English elocution, fundamentally considered, are the same, to which soever of these three modes of utterance they may be applied, yet the practical excellencies and obvious difficulties of each being peculiar, the student of elocution, whatever department be his ultimate object, should practise in all three, since reader, reciter, and spontaneous speaker, have each something to learn, from the other two, for the full accomplishment of his own particular branch of the art.

Another and more rational division of the art of elocution may be made from a consideration of the subjects to which it is applied, or the circumstances under which it is exercised. According to this principle, elocution may be considered as distinguishable into the following kinds, 1. The conversational; 2. The narrative; 3. The didactic; 4. The authoritative or judicial; 5. The argumentative; 6. The persuasive; 7. The declamatory and impassioned; relative to each of which some general rules may be laid down both with respect to voice and enunciation: as that in the first, the enunciation should be easy and familiar, the tone simple, the inflection limited, and the pitch of the voice but just so far beyond a whisper as to render it tuneable. In the second, the enunciation, though exceedingly simple, should be somewhat more precise and emphatic; the tone clear, unostentatious, and impressive; level, but not monotonous. In the third, both tone and enunciation should be strong, firm, and emphatic; which in the authoritative and judicial should swell to something like pomp, mingled with a degree of firmness that in effect should border on austerity, and with respect to modulation, almost on monotony. In the argumentative, clearness of voice and perspicuity of enunciation are the principal objects. In the persuasive, the tones should be mild, insinuating, and pathetic, the pronunciation remote alike from the affectation of sonorousness and of precision. In this, indeed, as in the seventh and last description of elocution, the enunciation should rather be subservient to the tone, (that is to say, to the feelings,) than the tone to the enunciation, as the object of the speaker is rather to be understood by the heart than by the understanding. In subjects and passages of strong passion and emotion, the enunciation should be occasionally accelerated and retarded; apparently wild and irregular, but obedient always to the changes of passion and sentiment; the modulation extensively varied, and the voice ranging through great varieties of softness, force, and vehemence, of acuteness and gravity, and the whole compass of expressive or reflective intonation.

The four great schools of elocution, or rather the four  
great

## ELOCUTION.

great theatres for the exhibition of that talent, are, the bar, the pulpit, the senate, and the stage; and before we take leave of the subject, something ought to be said on each of these. We shall consider them, therefore, in their alphabetic order.

*Elocution of the Bar.*—The style of elocution adapted to this profession, will best be understood by considering the objects to which the eloquence of the bar is principally to be directed. These are, 1. To demonstrate, by the elucidation of evidence, disputed facts; 2. To convince, by arguments, the doubtful judgment; 3. To influence by persuasion, or controul by declamation, the passions, the sympathies and moral feelings of those upon whom the decision of a cause may depend. For the first of these, we require an elocution distinguished by impressive distinctness, an unaffected deliberation, and collected coolness; an enunciation precise without formality, at once terse and familiar; a deportment candid, firm, and unassuming. For the second, we demand an emphatic perspicuity; an air of decisive, but modest confidence; an ardour not impetuous, but chastened and restrained, by all the decorums of circumstance and situation. For the last, the noblest, and most arduous of all the exertions of forensic eloquence, are required, a range of elocutionary expression, as various as the passions and emotions to be commanded; an insinuating mildness, a melting or a kindling pathos; the tone, the look, the whole manner, gesticulation and deportment, should occasionally assume the entire range of expressive variety, from the most conciliating sympathy to the deepest solemnity, and even, perhaps, on some occasions to intimidating boldness. The occasions, indeed, on which all that is here demanded can with propriety be exerted by the forensic orator, may but rarely occur; but when they do occur, the opportunities are decisive, and the reputation of the pleader, who is fully qualified to avail himself of them, is stamped for ever.

*Elocution of the Pulpit.*—The objects of clerical eloquence have been oratorically thus enumerated, “to inform the understanding even of the inapprehensive; to arouse the slumbering conscience; to regulate the moral feelings; to restore the social sympathies, which the disparities of fortune have but too much tendency to suspend; to restrain the fury of ambition, and check the mad career of voluptuous prodigality; to unlock the iron grasp of avarice, and expand the liberal palm to deeds of charity; to humble the towering insolence of pride, and disarm the uplifted hand of oppression and revenge; to infuse the spirit of benevolence into the heart of unfeeling obduracy; to breathe the sacred love of peace into the bosoms of the turbulent, and the mild spirit of forbearance and toleration into the soul of persecuting bigotry and prejudice.” How far all these objects are, practically, in the contemplation of every orator of the pulpit, this is no place to discuss; but if such be, in reality, among the proper objects of pulpit eloquence, it is obvious that all, and more than all, that we have demanded for the elocution of the bar, is requisite in this species of elocution also. Among the indispensable requisites of such elocution, are a familiar simplicity, insinuating and endearing; an impressive energy, stimulative and arousing; a pathos varied, characteristic, and descriptive; and a sublimity awful, elevating, and commanding. A mingled solemnity and enthusiasm should occasionally give an air of inspiration to the preacher, and his pronunciation, and all the particulars of utterance properly included in the term enunciation, should be full, sonorous, and oratorical, rather than loose and colloquial. At the same time, nothing is more to be avoided than any overmarked peculiarity or affectation, or than the vulgar vehemence, the bawling and vociferation, which are sometimes mistaken for energy and oratorical animation.

The modes of elocution in this profession, are those of reading, as applied to portions of the scriptures, or to set forms of worship; of sermon, which may be either read, (according to the general custom of the church of England,) recited, (as is usual among the preachers of the church of Scotland,) or delivered spontaneously, (that is to say, from notes or reflections previously digested, without actual composition,) as has been recommended by bishop Burnet, and as is practised by some of our separatists, and even by a very small number of our regular clergy; and of prayer. Of the first of these, it is only necessary to say, that the only circumstance in which it should differ from any other species of reading, seems to be, that it should be rather more solemn, and deliberate, from respect to the place and the occasion to which it is accommodated. In all kinds of reading, the style of elocution should accord with the subject, the tone and manner should harmonize with the language and sentiment; and as the subjects of scriptural and devotional reading are so exceedingly diversified, it follows as a consequence, that the style of the reader should be diversified as widely; and that nothing can be more inconsistent with the objects of clerical elocution than monotony. With respect to the three modes of delivering a sermon, this is not the place for discussing their respective claims of preference; and what has been already said of the application of the same common principles to reading, recitation, and spontaneous speech, and the different kinds of excellence most attainable in each, precludes the necessity of particular rules for them respectively. In prayer, a solemn prostration of manner, with a considerable mixture of enthusiasm, seems particularly required; and an especial avoidance of all those odd tricks and peculiarities, into which ministers are so apt to fall. But the further consideration of this subject belongs, properly, to the title GESTURE.

*Elocution of the Senate.*—As the eloquence of the senate is partly deliberative, partly controversial, and partly declamatory, it requires an elocution uniting almost all the principal requisites enumerated under the two preceding heads; and it admits, and even occasionally demands, a more impetuous warmth, a more rapid and vehement emotion, than in either of the former instances could be at all decorous. The sermons of Massillon might require, or, at least, their effect might be heightened by a denunciative severity, an awful austerity of manner, that should impress his audience with all the ideas and feelings of a supernatural agency; and under such circumstances the oratory of the pulpit might seem to have been carried, even above the heights, and beyond the force of senatorial and popular oratory; but it is in the senate alone, and the popular assemblies of the nation, that the orator is to hurry away the impetuous passions, and transport the hearer into absolute action; and there only are, of course, required the full thunders of elocutionary energy. But it is not only in the fervid tones of an impetuous declamation, that the senatorial elocutionist should excel; in the calm dignity of a well modulated cadence, and the polished grace and propriety of enunciation, he should also surpass; and in the easy urbanity of tone and euphony (when the stronger exertions of eloquence are not required) he should manifest, at once, the dignity of the statesman, and the elegance and refinement of the polite scholar. How little these circumstances, (almost all of them within the reach of a well directed education,) are attended to, is but too generally known; and in the humble state of modern oratory (as judged by its effects) the consequences may but too well be discovered.

*Elocution of the Stage.*—The critical object of theatrical representation is imitation. Its excellence is *verisimilitude*. It is a moving picture, that exhibits sounds as well as ob-

jects,

jects, and a part of whose pigments are the tones of the human voice. Its elocution, therefore, should be that of Nature—Nature in her highest perfection. Ideal nature, if you please; superior, in perfection, to any thing that individual nature ever exhibited, but in principle nothing deviating from unsophisticated reality. The harmony may be more perfect, the intonation something more diversified, the inflection and range of the voice rather more extensive, the utterance a little more emphatic, and some other graces and observances may be carried a degree further than ever was observable (or perhaps practicable) in spontaneous speech and real life; but still that spontaneity and reality must be the models; and the elocution, in all essential particulars, that would be unfit for the bar, the pulpit, or the popular assembly (so far as the difference does not arise out of the different sentiments to be expressed and passions to be indulged or excited) is unfit for the stage also. It should be remembered, however, that the drama deals in the extremes of passion and emotion; that its moral requires that it should exhibit those passions bursting all bonds of decorum, and triumphing over the restraints of reason. The player has frequently to exhibit the judgment under the domination of passions; and is even to represent the full malignity of the worst, as well as the imprudent excesses of the best passions of our nature; while the passions of the orator are always, in reality, (though not always in appearance,) to be under the controul of his judgment; and all the malignant and evil passions are to be suppressed, or kept out of sight, any otherwise than as they may be mentioned, or alluded to, in moral reprehension. Hence even the simplicity and truth of principle may, and must produce, occasionally, much apparent difference of effect; and the same exercise of judgment (for the judgment of the player must, in reality, still be paramount over his passion, though he be exhibiting the very reverse) that leads the orator, to temper and qualify, may induce the actor, to exaggerate the passion. It is in these exaggerations, however, that the art and mastery of the performer are most severely tried, and taste and judgment are alike imperiously requisite. They are necessary undoubtedly to the perfection of his art; yet the instant the exaggeration is apparent, disgust begins;—the instant the vulgar feeling of wonder is excited, the tragedian sinks to a level with the rope dancer; and many a time ought he to be overwhelmed with confusion, by those very plaudits to the attainment of which he has sacrificed all the finer touches of nature that might have secured the genuine applause of sympathy and emotion. But fully to attain, or even distinctly to comprehend, the higher excellencies of theatrical elocution, requires a very different course of preparation and study from what generally falls to the destiny, or enters into the apprehensions of the professors of this art. It is not in the science of the green room, the library of the prompter, and the technical knowledge of stage trick, to make a finished actor. To deliver language well, it is necessary fully to comprehend it, not loosely and colloquially merely, but grammatically, etymologically, and sympathetically; to detect the nicest shades of allusion and discrimination, and enter into the sentiment of the author; to realize the passion, where passion is, and the character, where the composition is characteristic. To excel in any species of elocution, therefore, demands some knowledge of general literature; to be a master of that elocution that should illustrate the fine passages of Shakespeare, will require a knowledge of our language which, fully possessed, would entitle the elocutionist to the rare and valuable character of an *English scholar*. But the sources of human passion must be studied also; human nature must be known, in the general, and in the particular, in all ranks and conditions, and

under all circumstances and associations. The perceptions must be diligently cultivated; the discriminative powers must be well exercised; feeling, keen, vigorous, varied feeling, must be cherished; and the imagination must be perpetually at work. For the development of the flexible powers of the voice, no pains well directed can be too elaborate, and the mind should comprehend, and the ear should perceive the delicacies and varieties of rhythmus, with all the subtle nicety of a poet. The actor so qualified will discard from his elocution all the pedantries alike of the convent and of the green room; all professional affections and prescriptive peculiarities; he will copy nature in such a style, that nature in her turn will copy him; and like the great actors of Greece and Rome, he will be worthy to give, while he receives, instructions to another Cicero or Demosthenes.

ELODES, in *Botany*, Adanson 444. (Elodea; Juss. 255.) A genus formed by Adanson of the *Hypericum Ægyptiacum* of Linnæus, on account of an oblong scale or appendage to the claw of each petal, considered by Linnæus as a sort of nectary, to which opinion he was probably led by the analogy of the nectariferous glands in his own *Hypericum Elodes*. We see no reason to separate the above plant from *Hypericum*, nor does Jussieu more than hint at the measure. See *HYPERICUM*.

ELODES is also used among the ancient writers in *Medicine*, for a species of fever, attended with profuse sweats.

ELOGIUM, ELOGE, a praise, or panegyric, bestowed on any person or thing, in consideration of its merit.

The word is Latin, but formed of the Greek εὐλογία, commendation; which is compounded of εὐ, well, and λέγω, to say, or speak.

The secretary of the Royal Academy of Sciences at Paris formerly composed the eloges of such members as died; and delivered them at the next public meeting of the company. Funeral orations are eloges of eminent persons deceased.

Extravagant and improbable eloges are of the greatest disservice to their own design; and do, in effect, diminish the person whom they pretend to magnify, and degrade him whom they profess to exalt. Any worthy man may pass through the world, unquestioned and safe, with a moderate recommendation: but when he is set off and bedaubed with rhetoric, and embroidered so thick, that you cannot discern the ground, it awakens naturally (and not altogether unjustly) interest, curiosity, and envy; for all men pretend a share in reputation, and love not to see it engrossed, or monopolized; and are therefore apt to enquire (as of great estates suddenly got) whether the person so commended, came honestly by it, and of what credit the person is that tells the story.

ELOHA, in *Scripture*, the singular of Elohi, one of the names of God. See ELOHI.

ELOHI, ELOI, or ELOHIM, one of the names of God: But it is to be observed, that angels, princes, great men, judges, and even false gods, are sometimes called by this name. The connection of the discourse assists us in judging rightly concerning the true meaning of this word. It is the same as Eloha; one is the singular, the other the plural. Nevertheless, Elohim is often construed in the singular number, particularly when the true God is spoken of; but when false gods are spoken of, it is construed rather in the plural. Calmet, *Diction. Bibl.* See *JEHOVAH*.

ELOI. See ELOHI.

ELOIGNED, in *Law*. See *ELONGATA* and *ELONGATUS*.

ELOINE, signifies to remove, or send a great way off. Thus it is said, if such as be within age be eloined, so that they cannot come to sue personally, their next friends shall be admitted to sue for them. *Star. 13 Ed. I. cap. 15.*

ELOME,

ELOME, a name given by some authors to orpiment.

ELON, in *Ancient Geography*, a town of Palestine, in the tribe of Dan. Josh. xix. 43.

ELONGATA, in *Law*, is a return of the sheriff, that cattle are not to be found, or removed, so that he cannot make deliverance in replevin. 2 Lil. Abr. 454. 458.

ELONGATION, in *Astronomy*, The angle under which we see the distance of a planet from the sun, reduced to the ecliptic.

Let S T (*Plate XII. Astronomy. fig. 104.*) be the distance of the sun from the earth, S L the curvate distance of the planet from the sun, the angle T S L equal to the difference of longitude of the planet P and earth T seen from the sun, called the commutation; the resolution of the triangle T S L, in which the two sides and contained angle are given, will give the angle at the earth S T L, called the elongation, and this being taken from the longitude of the sun, if the planet is to the east, or right of the sun, will give the geocentric longitude of the planet.

The triangle S L T may be resolved by the following rule: the least side is to the greatest as radius is to the tangent of an angle, from which  $45^\circ$  must be taken. The tangent of the remainder, multiplied by the tangent of half the sum of the unknown angles, gives the tangent of half their difference, which must be added to or subtracted from the half sum to trace the angle of elongation. This angle is the least of the unknown angles in the case of an inferior planet when the half difference must be subtracted; it is the greatest for a superior planet when it must be added.

It is sometimes useful to recollect the following proportions.

The sine of the commutation is to the sine of the elongation as the tangent of the heliocentric latitude is to the tangent of the geocentric latitude.

The sine of the elongation is to the sine of the commutation as the curvate distance of the planet from the sun is to the curvate distance of the planet from the earth.

It is at the time of the greatest elongations of the inferior planets Mercury and Venus, that they are usually seen to the greatest advantage. The greatest elongation of Venus was, according to Ptolemy, from  $45^\circ 25''$  to  $47^\circ 35'$ , and that of Mercury between  $16^\circ 8'$  and  $28^\circ 37'$ . According to our modern tables these numbers are, for Venus  $44^\circ 57'$  to  $47^\circ 48'$ , and for Mercury  $17^\circ 36'$  to  $28^\circ 20'$ .

ELONGATION is also used, by some authors, for the difference in motion, between the swiftest and the slowest of two planets; or the quantity of space, whereby the one has overgone the other; called also *superation*.

The swiftest motion of the moon, with regard to the sun, is called the elongation of the moon from the sun. We also say diurnal elongation, horary elongation, &c.

ELONGATION, as it relates to *Fortification*, is a term used to express that deviation from the immediately regular construction, which is derived from a polygon formed upon a circle, to one formed upon an ellipsis, or oval: when this happens, only two of the faces retain that construction and proportion which would appertain to the respective circles of which they would each form a part. In this we consider the ellipsis in question to be drawn upon two circles, and having a line passing through both their centres, as well as through the centres of the two retained faces; which necessarily are parallel. The two sides, or *elongated* arcs of the ellipsis, may be divided into any number of faces, according to the extent of the area inclosed; they are usually on the scale of the *greater* system, while the ends are on the scale of the *mean* system. Sometimes the elongation must be made so as to occupy a great extent of

front; in which case it may become expedient to throw forth a crown-work from the centre of the *elongated* arc, or line, in order to prevent the enemy from occupying any part of the esplanade sufficiently near to batter those works which may be rather weak for want of a flanking fire sufficiently powerful to impede the besiegers. These crown-works answer much the same purpose as advanced redoubts in front of a line of entrenchments, and scour the whole advance so completely, enfilading the assailants, as to render it peremptorily necessary to become matters of them before the lines can be carried. This will shew not only their ability, but the absolute necessity for constructing all such advanced defences, in that scientific manner which may render them untenable by the enemy, after being possessed by them, as well as perfectly incompetent to make any impression on the intrenchments, which would command them *in reverse*, that is, in their rear, and compel the enemy to quit. Crown-works being on a more important scale, require that every attention should be paid that their batteries should not bear upon any of the main defences.

The foregoing relates to regular works: for the irregular we have scarcely any thing like a defined rule; but it must always be held in mind, that the more the defences are elongated, the more they will require additional support, either from various lines of fortification one within the other, or from detached works, so situated as to defend the weaker parts. This necessity arises chiefly from the salient angles being rarely allowed to fall within  $90^\circ$ , lest they should plunge upon some other parts of the defences; whereas in all works formed upon a pentagon, hexagon, heptagon, or even an octagon, the angles of the bastions may be considerably reduced, and the ravelines equally so; it is owing to this that fortresses, on a large scale, not only admit, but require, numerous additional defences to fill up the several intervals between the exterior salient angles, or extremes of the defences, but to prevent the enemy from occupying positions favourable to their views.

We do not term works constructed in an irregular manner along the shores of a bay, or around a peninsula, *elongated*; they may be carried for miles without coming under that designation; it is only when a line of defence, and particularly fortifications, forming a figure either perfectly regular, or nearly so, are in every particular part extended, for the purpose of embracing more space, or conforming to any particular local circumstance, that we consider the term *elongation* to be applicable.

In *Tactics*, the term implies such an extension of the front as is produced artificially, without the aid of reinforcements. Thus, we draw up troops only two, instead of three, deep, for the purpose of elongating our front; which consequently thus becomes extended to half as much more as it formerly occupied in length. This is often necessary, but it certainly weakens the fire and the resistance throughout; besides, it prevents the casualties in the front from being so readily filled up, and is apt to leave gaps, or openings, through which the enemy's cavalry may make a charge.

Where it is absolutely necessary to retain a very firm front, yet to extend it so far as local means may allow, especially where it is principally intended to repel the enemy's horse, those parts of the line which may be most exposed by the evenness of the ground, &c. ought to be blocked by *abbatis*, that is, timber felled and laid in such a manner as should obstruct the passage of cavalry; behind these a few men should be dispersed to prick off any of the assailants who should attempt to cut an opening, or to drag away the trees, so as to obtain admission. Frequently trees can be cut down, but cannot be drawn away to any

chosen spot: in such case, their trunks and principal branches may be left, while their lesser boughs may be cut into stakes and palisades for the defence of other parts. The line will of course be elongated by such devices, while the more exposed parts may retain their effective strength. Where a convoy is in question, and that the attack upon it can be made only upon one long front, which cannot be entirely covered by the waggons, &c. then, placing the artillery in the most commanding situations, the infantry must be ranged in such manner as may *elongate* the defences, and keep the enemy in check. This will be peculiarly necessary where a neighbouring height must be cut off from the enemy's possession, though it could not be occupied by the defenders of the convoy without weakening and dividing them.

The elongation of an attack, is where only a small front is shewn at first, but is gradually extended so as to embrace a greater portion of the defences: thus, when after opening a battery upon a bastion only, other batteries are made to bear upon the curtain almost parallel thereto; in such case, we suppose only a bridge-head, or a *fleche* to exist, but no raveline. Likewise, when a column of infantry bearing down upon, and menacing only one particular point, suddenly deploys, and acts upon a greater extent of line, the attack is said to be *elongated*. But, in either case, the term does not apply to any additional force brought to act on the same point; it relates to extension merely.

**ELONGATION**, in *Surgery*, is an imperfect luxation; when the ligament of any joint is so extended, or relaxed, as to lengthen the limb, but yet not to let the bone go quite out of its place. See **LUXATION**.

**ELONGATUS**, **ELOIGNED**, a return of the sheriff that a person is conveyed out of his jurisdiction. See writ *de HOMINE REPLEGIANDO*.

**ELOPEMENT**, in *Law*, is when a married woman, of her own accord, departs from her husband, and dwells with an adulterer; for which, without voluntary reconciliation to the husband, she shall lose her dowry; nor shall the husband, in such case, be compelled to allow her any alimony. Stat. Westm. 2. 13 Edw. I. c. 34. See **DIVORCE** and **DOWER**.

“Sponte virum mulier fugiens, & adultera facta,  
Dote sua careat, nisi sponso sponte retracta.”

The word is formed from the Belgic, *Ee*, matrimony, and *loopen*, to run away.

However, mere advertising a wife in the Gazette, or other public papers, is not a legal notice to persons in general not to trust her; though a personal notice given by the husband to particular persons is said to be good. An action lies, and large damages are usually given, against a person for carrying away, and detaining another man's wife. See **FORCIBLE ABDUCTION** and **RAVISHMENT**.

**ELOPS**, in *Ichthyology*, a genus of abdominal fishes, the character of which, according to the Linnæan system, consists in having the head smooth; edges of the jaws and palate rough with teeth; gill-membrane with thirty rays, and armed on the outside in the middle with five teeth.

The genus *elops* is defined by Bloch as having the gill-membrane furnished with more than thirty rays, (specimens he examined exhibiting thirty-four,) and Boie admits there should not be less than thirty to constitute the genus. Bloch considers the bony shield or plate beneath the chin, and the dorsal fin being placed opposite the ventral, as essential characters of the genus.

The only species of this genus at present known is the Linnæan *elops saurus*; le lézard of the French writers.

Perhaps the earliest describer of this fish is sir Hans Sloane, who, in the second volume of his history of Jamaica, gives a figure and detailed description. He speaks of it under the name of *saurus maximus*, and acquaints us that it is called in Jamaica the *sein-fish*, or sea gally-wasp. “This fish (he observes) was about fourteen inches long, in the middle five inches round, and tapering to both ends; the mouth in both jaws had one row of small sharp teeth, and on the upper two more within, parallel to them, and a row of the same on the upper part of the cartilaginous tongue; three quarters of an inch from the end of the snout were the eyes, round, and grey; there were two *pinne post branchias*, two under the belly, one on the middle of the back, *post anum* another, and a forked tail; it was all over scaly, the back of a dark brown, and the belly of a white colour.” The species is found in various parts of the American seas; it was met with by Dr. Garden about Carolina, and communicated by him to Linnæus. The strong spine at each side of the tail is considered as a specific distinction of *elops saurus* by Linnæus, Gmelin, and others, but this must obviously remain a very doubtful character till another species at least of the same genus be discovered in order to ascertain whether such spines be not characteristic of the genus instead of the species.

It has been observed by writers that *elops saurus* bears some resemblance to a pike, or rather to a salmon; with the former it has no kind of affinity whatever, but on the contrary it is so closely allied to the *salmo* tribe that were it not from being destitute of the fleshy rayless fin, so uniformly observable on the lower part of the back in the salmon kind, we should be almost induced to refer it to that genus.

The head of *elops saurus* is without scales. The lower jaw rather longer than the upper. Both jaws, together with the tongue and palate, are armed with a vast number of small teeth. The eyes nearly vertical; the irides double, the inner one yellow, exterior red, and the pupil black; and the eyes partly covered with the skin of the head. The body of this fish is slender, and the scales large; the head yellowish, back blueish, sides silvery. The lateral line is straight. All the fins brownish; the exterior half of the pectoral fin, anterior part of the dorsal fin, and extremity of the tail blueish. The tail is much furcated, and divided in the middle by a distinct longitudinal stripe of black.

**ELOPS**, *Ελωψ*, in *Zoology*, the name of a serpent, otherwise called *elaps*.

**ELOQUENCE**, the art of speaking or writing well, so as to move and persuade. The term, however, in its greatest latitude, denotes that art or talent, by which the discourse is adapted to its end; “*Dicere secundum virtutem orationis. Scientia bene dicendi.*” Quintilian. In common conversation, however, the word eloquence is seldom used in such a comprehensive sense. But this definition exactly corresponds to Tully's idea of a perfect orator; “*Optimus est orator qui dicendo animos audientium et docet, et delectat, et permovet.*” Accordingly all the ends of speaking are reducible to four; every discourse or speech being intended to enlighten the understanding, to please the imagination, to move the passions, or to influence the will. When a speaker addresses himself to the understanding his aim is to inform, and to convince, for the former of which purposes the predominant quality is perspicuity, and for the attainment of the latter, argument. By the first we are made to know, and by the second to believe. The imagination is addressed, by exhibiting to it a lively and beautiful representation of a suitable object. As in this exhibition, the task of the orator may be said to resemble that of the painter, which consists in imitation, the merit of the performance

results entirely from the two following sources, *viz.* dignity, as well in the subject, or thing imitated, as in the manner of imitation, and resemblance, in the portrait or performance. This address attains the summit of perfection in the *sublime*, (which see,) or those great and noble images, which, presented to the mind in suitable colouring, expand, as it were, the imagination with some vast conception, and quite ravish the soul. The characteristic of the third species of discourse, or that which is addressed to the passions, is the *pathetic*. (See *PASSIONS* and *PATHOS*.) But the most complex and most important of all the kinds of eloquence is that which is calculated to influence the will and to persuade to a certain course of conduct. This is an artful mixture, of that which proposes to convince the judgment, and of that which interests the passions; and its distinguishing excellence results from these two, the argumentative and the pathetic duly blended. These, combining their force and acting in concert, constitute that *vehemence* of address, which is admirably fitted for persuasion, and has always been regarded as the supreme qualification in an orator. This animated reasoning was by the Greek rhetoricians termed *ênocheia*, and from signifying the principal excellency in an orator was used at length to denote oratory itself. Hence, as vehemence and eloquence became synonymous, the latter, in conformity to this mode of thinking, was sometimes defined "the art of persuasion." In order to persuade, which, though not the only object of eloquence, is the most important and for many reasons the most difficult, the most essential requisites are solid argument; clear method, a character of probity appearing in the speaker, joined with such graces of style and utterance as shall command attention to what he says. Hearers who exercise their understanding cannot be persuaded, without being convinced; but conviction and persuasion, though they are sometimes confounded, ought to be distinguished from each other. Conviction affects the understanding only; persuasion, the will and the practice. It is the business of the philosopher to convince a person of the truth; but it is the business of the orator to persuade him to act agreeably to it, by engaging the affections of the hearer. Conviction and persuasion ought always to accompany each other, but this is not universally the case; because the inclinations do not regularly follow the dictates of the understanding. The inclination may revolt, though the understanding be satisfied; the passions may prevail against the judgment. Conviction, however, is one avenue to the inclination, or heart; and it is that which an orator should first endeavour by his utmost efforts to gain; for no persuasion is likely to be stable, which is not founded on conviction. But in order to persuade, the orator must do more than produce mere conviction; he must duly consider the nature of man, and endeavour to act upon the different springs by which he is moved. He must address himself to the passions; he must paint to the fancy, and touch the heart; and hence, besides solid argument and clear method, all the conciliating and interesting arts, both of composition and pronunciation, enter into the idea of eloquence.

"We may distinguish," says Dr. Blair, (*Lectures*, vol. ii.) "three kinds, or degrees, of eloquence. The first, and lowest, is that which aims only at pleasing the hearer. Such, generally, is the eloquence of panegyrics, inaugural orations, addresses to great men, and other harangues of this sort. This ornamental sort of composition is not altogether to be rejected. It may innocently amuse and entertain the mind; and it may be mixed, at the same time, with very useful sentiments. But it must be confessed, that where the speaker has no farther aim than merely to shine and to please, there is great danger

of art being strained into ostentation, and of the composition becoming tiresome and languid.

"A second and a higher degree of eloquence is when the speaker aims not merely to please, but also to inform, to instruct, to convince; when his art is exerted in removing prejudices against himself and his cause, in choosing the most proper arguments, stating them with the greatest force, arranging them in the best order, expressing and delivering them with propriety and beauty, and thereby disposing us to pass that judgment, or embrace that side of the cause, to which he seeks to bring us. Within this compals, chiefly, is employed the eloquence of the bar.

"But there is a third and still higher degree of eloquence, wherein a greater power is exerted over the human mind; by which we are not only convinced, but are interested, agitated, and carried along with the speaker; our passions are made to rise together with his; we enter into all his emotions, we love, we detest, we resent, according as he inspires us; and are prompted to resolve or to act, with vigour and warmth. Debate, in popular assemblies, opens the most illustrious field to this species of eloquence; and the pulpit also admits it." See farther on the different species of eloquence under the article *ELOCUTION*. For the history of eloquence, and an account of the most distinguished orators; see *ORATORY* and *ORATOR*. Those who distinguish between eloquence and rhetoric represent the latter as proposing and explaining the theory, and the former as the practice of the art; but they are generally used indiscriminately for each other. See *ELOCUTION* and *RHETORIC*. On the subject of this article, see Campbell's *Philosophy of Rhetoric*, Blair's *Lectures*, vol. ii. and Cambray's *Dialogues on Eloquence*.

*ELORA*, or *ELLORA*, in *Geography*, a town of Hindoostan, in the vicinity of Dowlatabad, famous for its numerous pagodas, most of which are cut out of the natural rock. M. Thevenot, who has particularly described them, says, that for two leagues together nothing is to be seen but pagodas, in which are some thousands of figures. The sculpture of them he does not much commend; and we may apprehend, says major Rennell, that they are of early Hindoo origin. It should be recollected, that Deoghire, which stood in this neighbourhood, was the greatest and richest principality in the Deccan; and that the fame of its riches incited Alla to attack it in 1293; and these elaborate monuments of superstition were probably, as Rennell suggests, the offspring of that abundant wealth, under a government purely Hindoo. Sir C. W. Malet has given a particular account of these wonderful excavations, illustrated with drawings, in the sixth volume of the "*Asiatic Researches*." As to their origin or date no inquiry which he had been able to make afforded him satisfaction. He has no doubt, however, that they are the works of people, whose religion and mythology were purely Hindoo; and he adds, that most of the excavations carry strong marks of dedication to "Mahdew," as the presiding deity. Nevertheless he suggests, that the most northerly caves of Ellora, occupied by naked sitting and standing figures, are the works of the "Sewras" or "Juttees," who by the Brahmens are esteemed schismatics, and whose sect, called "Srawuk," is very numerous in Guzerat. The tenets, observances, and habits of the "Sewras" are peculiar, and in many points very different from other Hindus. Their adoration of the deity is conveyed through the mediation of "Adnaut" and "Parisnaut," the visible objects of their worship, personified as a naked man sitting or standing. This sect is supposed to be of a comparatively modern origin; and if this be the case, and the hypothesis of the dedication of the temples to their idol be admitted,

admitted, the limit of their possible antiquity will be assigned; but without ascertaining, or affecting, that of the others. As to the antiquity of these astonishing works, this writer has detailed two different accounts; one given by an intelligent Mahometan and another by a Hindu. The account of the first is said to have been derived from a person of acknowledged erudition. The second was deduced from a book, entitled "Sewa Lye Mahat," or the grandeur of the mansion of Sewa, *i. e.* Mahdew. The Mahometan reported, that "the town of Ellora was built by rajah Eel, who also excavated the temples, and being pleased with them, formed the fortrefs of Deoghire (Dowlatabad,) which is a curious compound of excavation, scarping, and building, by which the mountains were converted into a fort, resembling, as some say, the insulated temple in the area of the "Indur Subba" (one of the pagodas.) Eel rajah was contemporary with Shah Momin Araf, who lived 900 years ago." The Brahmen, on the other hand, said, "that the excavations of Ellora are 7894 years old, formed by Eeloo rajah, the son of Peshpout of Elichpore, when 3000 years of the Dwarpa Youg were unaccomplished, which, added to 4894 of the present Kal Youg, makes 7894." Our author inclines to the former opinion. He farther informs us, that the "Koond," or cistern, mentioned by the Brahmens, is still in excellent preservation, just without the town of Ellora; and the holiness of its water is even now in such high estimation as to render it a "Teerut" (pilgrimage) of great reputation and resort, under the appellation of "Sewalla Teeruit," or "Kond." There are many other excavations in a semicircular mountain, that commands a view of the fine valley of Ellora. In order to account for these extraordinary works, and the situation in which they were constructed, it should be considered, that the ancient Brahmens avoided the contamination of cities, and affected the purity and simplicity of rural retirement. In situations remote from observation, the imagination of their disciples probably enhanced the merits of their sanctity. Accordingly, to alleviate austerities, and to gratify the devout propensities of these holy men, became objects of pious emulation. Under the influence of this principle, the munificence of princes may have engaged to provide them retreats, which, sanctified by the symbols of their adoration, were at once suited, in simplicity and seclusion, to those for whom they were intended, and in grandeur to the magnificence of their founders. Thus power and wealth may have been combined, under the guidance of enthusiasm, to produce monuments, scarcely less extraordinary or less permanent, though less conspicuous and less known, than the pyramids of Egypt. Although some of these excavations are of very ancient origin, there are others, and particularly two, in a hill near a garden in the neighbourhood of Aurungabad, formed, as it is confidently asserted, by rajah Paur Sing, one of the Rajpoot Ameers of Aurungzebe's court, as a place of retirement, during his attendance on that monarch in his excursions to the neighbouring garden.

ELOTZ, a town of Russia, in the district of Orlof; 112 miles E.N.E. of Orel. N. lat. 53° 20'. E. long. 39° 14'.

ELOVKA, a town of Russia, in the government of Tobolsk; 16 miles W. N. W. of Tomsk.

ELOY, NICHOLAS FRANCIS JOSEPH, in *Biography*, was born at Mons, in the province of Hainault, on the 20th of September 1714, and died on the 10th of March 1788, having exercised his profession as a physician with great ability and disinterested humanity. He was a man of extensive learning, and great modesty, and much addicted to study; whence, notwithstanding his professional avocations, he was enabled to write upon a variety of topics, and his

publications are numerous. His first work, which was published in 1750, was a small treatise, entitled "Reflexions sur l'Usage du Thé." His next publication was an attempt at a history of medicine, arranged in the form of a dictionary, and entitled "Essai du Dictionnaire Historique de la Médecine Ancienne et Moderne," in two volumes octavo; which appeared in the year 1755; this work was afterwards greatly enlarged, by extending the different articles which it contained, and was published in 1778, in four volumes quarto, with the title of "Dictionnaire Historique de la Médecine Ancienne et Moderne;" to which, as our readers will have observed, we have been much indebted for information relative to the different medical characters, of whom we have already given a biographical account. Eloy likewise published, in 1755, a small volume, entitled "Cours Elementaire des Accouchemens;" and, a few years previous to his death, *viz.* in the years 1780 and 1781, he committed to the press two other essays, the first of which was entitled "Memoire sur la Marche, la Nature, les Causes, et le Traitement de la Dyssenterie;" and the other, "Question Medico-politique; si l'Usage du café est avantageux à la santé, et s'il peut se concilier avec le bien de l'état dans les Provinces Beligiques?" As a slight reward for the patriotic zeal manifested in this tract, the estates of Hainault presented him with a superb snuff-box, with this inscription, "Ex Dono Patriæ;" *the Gift of his Country.* He held the honourable office of physician to prince Charles of Lorraine. *Nouveau Dict. Hist.* &c. Lyon, 1804.

ELPHIN, in *Geography*, a post town of the county of Roscommon, province of Munster, Ireland, 75 Irish miles W. by N. from Dublin, and 7 miles S. from Carrick, on Shannon.

ELPHIN, a bishopric in Ireland, in the archi-episcopal province of Tuam. It dates its origin from St. Patrick, in the middle of the 5th century. It comprizes the greater part of the county of Roscommon, a large scope in Sligo and Galway, and a very little in Mayo; and is reckoned one of the most valuable of the Irish bishoprics. There are 75 parishes, which are formed into 29 benefices, and of these 26 have churches, which are the only ones in a tract of 420,150 Irish acres! The cathedral is a poor parish church, but the bishop's palace is a very good modern house, in the midst of an excellent demesne, and adjoining the small town of Elphin. Beaufort.

ELPHINSTON, WILLIAM, in *Biography*, a Scotch prelate and statesman, was born at Glasgow about the year 1431. He was educated at the University of his native place, and became distinguished for his proficiency in the learning of the times. He afterwards went to Paris, where he studied the civil and canon law, and likewise delivered lectures with great reputation for several years. Upon his return to Scotland he was promoted to church livings, and admitted a member of the king's council. He was, soon after this, appointed a joint commissioner with the bishop of Dunkeld and the earl of Buchan, in settling some disputes between the courts of Scotland and France. As a reward for the prudence and eloquence which Mr. Elphinston displayed on this occasion, he was, on his return, nominated to the bishopric of Ross; whence, about the year 1484, he was translated to the see of Aberdeen, and appointed, at the same time, to the chancellorship of the kingdom, an office which he held some time with the highest reputation; but when the troubles which took place between the king, James III., and his discontented nobility, had involved the kingdom in a civil war, he abandoned public state affairs, and confined

himself wholly to the duties of his bishopric. But, on the accession of James IV. his talents as a statesman were again called into exercise, and from this time his sovereign undertook no affairs of moment without his advice and concurrence. He died in 1514, at the advanced age of eighty-three, leaving behind him an excellent character; he was the patron of learning and learned men, and it is supposed, that by his influence the bull was obtained from the pope, for establishing a university at Aberdeen, with as ample privileges as were enjoyed by the most favoured seats of learning; and to his personal exertions and superintendance, it was chiefly owing that the building of King's college was undertaken and completed. To that foundation he proved himself a munificent benefactor during the remainder of his life; and, at his death, when he bequeathed large sums of money for its support. Gen. Biog.

ELPISTICI, *Ελπιστικοί*, among the Greeks, a sect of philosophers, who made hope the ruling passion of mankind.

ELRICH, in *Geography*, a town of Germany, in the circle of Upper Saxony, and county of Klettenburg; formerly the capital of the county; in which are some considerable manufactures; 6 miles N. W. of Nordhausen.

ELRICK, or EGELRIC ROAD, in *Antiquity*, was an ancient artificial road, made with great labour and expence through the fens, ten miles from Spalding to Deeping, by Egelric, abbot of Crowland, in the county of Lincoln, and afterwards bishop of Durham; who, as Ingulphus relates in his history of that monastery, raised, by means of wood and gravel, a causeway, or causey, for travellers, through the centre of a wild forest and deep marshes, called, after him, Egelric; or, by abbreviation, Elic-road. A part of it is still visible, lined with willows, between the river Welland, and the marshes north of Crowland. Gough's Translation of Ingulphus's History of Crowland.

ELS, in *Geography*, a town of Moravia, in the circle of Brunn, 32 miles W. of Olmutz, and 24 N. N. W. of Brunn.

ELSA, a river of Tuscany, which runs into the Arno, about a mile W. from Empoli.

ELSE, a river of Silesia, which runs into the Oder, near Oderburg.

ELSEN, a small town of France, in the department of the Roer, chief place of a canton in the district of Cologne, with a population of 304 individuals. But the canton contains 36 communes, and 12,239 inhabitants.

ELSEN, a town of Germany, in the kingdom of Westphalia, and bishopric of Paderborn; 2 miles W. N. W. of Paderborn.

ELSFLETH, a small town of Germany, in the duchy of Oldenburg; situated on the river Weser, where the duke of Oldenburg exacts a considerable toll from all vessels sailing up the river towards Bremen. At the peace of Lunenburg, the duke was offered an indemnity for this toll, with the view to favour the commerce of Bremen; but its produce is so important, that the duke would not consent to its abolition.

ELSGAU, a bailliage of Switzerland, being part of the bishopric of Basle, lying between the mountains and the Larg, and comprehending the town and bailiwick of Porentru, and 20 parishes.

ELSCHEIMER, ADAM, in *Biography*, a painter of very extraordinary talents, standing quite alone in the peculiar province of the list he adopted, *viz.* small pictures of landscapes with figures, and of small figures with landscape back-grounds. The figures being in some the prin-

cipal object, and occupying the largest portion of the space of the picture; and, in others, the landscapes being the most important. He was born at Franckfort; at what period, those who have written his life, differ much in stating; but the best authorities determine it to have been in 1574, and his death to have happened in 1620, so that he lived only 46 years.

He was at first a disciple of Philip Uffenbach, whom he soon excelled, and then determined to go to Rome, where alone he could acquire that high taste to which he aspired.

After some time spent in study of the fine works there exposed to his view, and an intimacy with many eminent painters, he fixed upon that style of art which has been mentioned as decidedly his own; in which no one had ever before exerted himself; and in which no one has ever since so highly excelled as Elsheimer.

That which renders his pictures so interesting is, the grandeur of style in which they are executed. Many of his figures partake so much of Raphael's best manner of character, of action, and disposition of the draperies, that if they were magnified, they would appear to be of that great master's own hand; and they have superadded a colour which is of a superior class; in the production of which, indeed, the smallness of their size was of considerable assistance to him; for it is by no means so easy to extend a full body of colour over a large surface, with equally pleasing variety of tone, and freedom of execution; and in it to separate and form the distinct parts as in a smaller one; and though it requires more neatness in the execution of the latter, it does not demand so free and so ready a hand to unite, to blend, and soften the various parts, and to give expression its full force, as in the former.

His pictures exhibit great attention to nature; particularly his perspective is very perfect, in lines, at least; and he not unfrequently chose very difficult things to manage: such as working with a short perspective distance, and sometimes placing his figures on the top of a hill, and suddenly losing the ground, till it is recovered again in a deep valley. His landscapes have, in general, the air of real views, and are finished with wonderful attention to general form, and beautiful scenery. Their colour is not always exactly that of nature, but as seen under a peculiar illumination, like the tone which Titian has adopted in his St. Peter Martyr; giving it an air of grandeur not to be obtained, perhaps, by the brighter hues of nature.

From the extreme care and excellence with which his works are finished, they were not, of course, in his short life, very numerous; and are rarely to be met with. The richest collection of them in this country is at the earl of Egremont's, at Petworth, in Suffex. There are ten pictures by him, eight of which are of one size, *viz.* about four inches high, by two and a half wide, or perhaps a little more. The subjects are, a St. Peter, St. Paul, St. John Baptist, Tobit and the Angel with a Fish, an old Woman and a Girl, an old Man with a Boy, and a Capuchin Friar, with a model of a convent in his hand. The figures in all these are about three inches high, yet their characters and expressions are just and excellent; and the drawing of their figures, and the draperies, in the best style of art. Another picture represents the interior of a brothel by fire and candle light, in which there are ten or more figures gaming, and indulging in the licentiousness of such a place, all exquisitely wrought; with some expressions that have never been surpassed, although the figures are not more than two inches and a half high. The last is Nicodemus's visit to Christ; but it is not of so good a quality as the others.

The subjects he chose were generally moon light or candle light pieces, which he painted with great lightness, spirit, and delicacy of touch, and with great knowledge of the chiaro-scuro, and excellent colour; and with such finish, that every part will bear the minutest inspection.

While he lived his pictures bore high prices, and they of course were greatly enhanced on his death; one of them is mentioned by Houbraken, representing Pomona, as having sold for 800 German florins. There are engravings from many of Elsheimer's pictures by his friend and benefactor, count Gaud; but they are in general too heavy and black, and have a flatness of effect, particularly in the trees, very unlike the originals; among them is one from his most famed picture, the Flight into Egypt, a moonlight. It is now, with two others of different subjects, in the National Museum at Paris.

Elsheimer, though thus endowed with taste and skill, was not the favourite of fortune. Notwithstanding he obtained great prices for what he did, yet his care in the execution of them, and the time they cost him to finish, were not so recompensed as to enable him to live and maintain a large family with comfort. As what he earned by his paintings would not find sustenance for himself and them, he fell into debt, and was cast into prison; the disgrace of which, though he was not suffered to remain long confined, is said to have preyed on his spirits, and hastened his dissolution. He was greatly regretted, and his works eagerly bought up, even by the Italians. The grand duke of Tuscany had several of them, and the world justly lamented the severe fortune of so extraordinary a genius, who deserved far more felicity than he was permitted to enjoy.

Elsheimer is highly celebrated, says another writer, for his careful pencil and extraordinary effects of light. Most of his landscapes are illumined by fire, or by moon, or torch light; and in them he has introduced small historical figures, which are highly appropriate to the scenes, and most exquisitely painted: yet his Aurora, of which there is an excellent print by count Gaudt, shews that bright and sudden light was not absolutely necessary to the display of his powers, and that he dipped his pencil in early dawn, with equal felicity.

The accuracy of his observation, and the retention of his memory were great, and the skill was scarcely less with which he introduced into his compositions, such picturesque incidents as he had once seen. Pilkington says that "it is impossible to conceive any thing more exquisite in painting than the productions of the pencil of Elsheimer; for whether we consider the fine taste of his design; the neatness and correctness of the drawing of his figures; the admirable management and distribution of his lights and shades; the lightness, the spirit, and the delicacy of his touch; or the excellence of colouring; we are astonished to observe such combined perfections in one artist; in whose works even the minutest parts will bear the most critical inspection, and the whole together is inexpressibly beautiful. He understood the principles of chiaro-scuro to the utmost perfection; and shewed the solidity of his judgment in the management of his subjects, which for the most part were night-pieces, by candle, or torch light," &c.

With these high claims to contemporary patronage, it was the fate of Elsheimer to fall a martyr to his own merits. Not affluence, nor even comfort, attended him in his professional pursuits. His family was numerous, and the great care with which his sensibility to the minuter beauties of nature prompted him to finish his pictures, occupied so

much time, that he was gradually overwhelmed with debts, and cast into prison. Being much respected, he was soon released; probably by his friend Gaudt, the engraver: but returned, spirit-broken, to his art, and survived not long. Posterity will reverence his professional merits, and regret his misfortunes.

Of artists of transcendent talent, it has been the frequent lot to receive from their contemporaries but a trifling earnest, either of the value of their works, or the extent of their fame: so blind is taste, with all its lofty pretensions, or so reluctant is human nature to recognise the claims of living excellence.

Among the most celebrated of his works, which are known through Europe, by the diffusion of count Gaudt's excellent engravings after them; may be mentioned his "Flight into Egypt," wherein he has contrasted the effects of fire and moonlight; two landscapes, in each of which he has introduced "Tobit and the Angel;" a "Cottage Door by Candle-light, with Ceres drinking from a Pitcher;" the story of "Baucis and Philemon;" the "Decollation of John the Baptist;" "Latona and her Sons, with the Lycian Peasants metamorphosed into Frogs;" and the "Death of Procris:" the two latter subjects were engraven in England by Magdalen Paff. Some of his most valued performances were late in the gallery of the grand duke of Tuscany. L.

ELSHOLTZIA, in *Botany*, so named by professor Willdenow in memory of a Prussian botanist, John Sigismund Elsholtz, who lived in the middle of the 17th century, and published a *Flora Marchica*, or catalogue of plants cultivated in the principal gardens of Brandenburg, printed at Berlin in 1663, in small 8vo. Willdenow mentions also a manuscript work on Horticulture by the same writer in his native tongue, preserved in the royal library of Berlin.—Willden. in *Römer Usteris Magazine*, fasc. II. 1. t. 1. Sp. Pl. v. 3. 59. Class and order, *Didynamia Gymnospermia*. Nat. Ord. *Labiata*, sect. 3. Juss.

Gen. Ch. *Cal.* Perianth of one leaf, bell-shaped, with ten furrows, and five oblong acute teeth; the orifice closed with hairs. *Cor.* of one petal, ringent; tube cylindrical, short, the length of the calyx: upper lip shortest, obtuse, concave, four-toothed, clothed externally with long white hairs; lower obtuse, straight, sharply crenate, externally clothed with hairs. *Stam.* Filaments four; the two uppermost shortest, lodged in the upper lip; the two lowermost in the under one: anthers roundish. *Pist.* Germens four, roundish, superior; style thread-shaped: stigma cloven. *Peric.* none. *Seeds* four, naked, brownish, in the bottom of the calyx. Willdenow.

Ess. Ch. Calyx tubular, five-cleft. Corolla ringent; upper lip four-toothed; lower longest, undivided, finely crenate. Stamens distant.

1. *E. cristata*. Willd. as above. (*Hyssopus ocymsifolius*; Lamarck *Encycl.* v. 3. 187.) "Spikes solitary, erect." Native of Siberia, about the lake Baikal. *Root* annual, fibrous. *Herb* with the habit of an *ocymum*, and a very fragrant scent, especially when rubbed after drying, compared by some to roses, but in our opinion more resembling the muscat grape. *Stem* a foot or more in height, square, leafy, with opposite branches. *Leaves* stalked, opposite, ovate, acute, serrated, light green, smooth. *Spikes* terminal, solitary, stalked, unilateral, consisting on one side of a double row of obovate, pointed, imbricated bractees, and on the other of three or four dense rows of pale lilac-coloured flowers. This plant is propagated by seed, with little trouble, in our gardens, but has more singularity than beauty in its aspect. The scent indeed renders it desirable.

2. *E. paniculata*. Willd. Sp. Pl. v. 3. 59. (*Hyssopus cristatus*; Lamarec. Encycl. v. 3. 187. Manám-podam; Rheede Hort. Mal. v. 10. 129. t. 65.) "Spikes panicled, reflexed." Native of moist places on the coast of Malabar. Lamarck, who had in his possession fine specimens of this plant from Sonnerat, assures us that the leaves are not alternate, as drawn in the *Hortus Malabaricus*, but opposite as in the preceding species, with which he rightly perceived its generic affinity. The chief specific difference seems to be in the inflorescence, which in the plant we are describing is panicled, each branch of the panicle consisting of a numerous series of reflexed spikes, shorter than in the former, with more oblique, unequally cordate, bracteas. Every part of this herb is said to exhale an agreeable aromatic odour. The root seems to be annual.

ELSIMBURG, in *Geography*. See HELSINBURG.

ELSINEUR, in Danish *Helsingør*, a handsome town of Denmark, in the island of Zealand, at the entrance of the Baltic, opposite the Swedish coast, 20 miles N. of Copenhagen. E. long.  $12^{\circ} 34'$ . N. lat.  $55^{\circ} 58'$ . The population amounts to between 6 and 7000 individuals. It derives its name from the Helsingers, an ancient Gothic colony, and is situated on the declivity of a hill, almost directly over-against Helsingburg, in the Swedish province of Scania. The passage is not above 4 English miles. The narrow arm of the sea, which joins the North sea and the Baltic, is called the Oeresund, or *Sound*, and is protected by the castle of *Cronenburg*, which see.

Till the year 1425, when king Erick of Pomerania bestowed on it the privileges of a city, Elsinour was but a small insignificant place. It has two churches, a grammar-school, several handsome private buildings, and a sugar-house. In 1753, a harbour was attempted, but the execution of the project was found impracticable. The roadstead, however, is excellent.

The principal trade of Elsinour is in wine and spirituous liquors; but it derives all its importance from the Sound dues, which, in times of peace, are paid at Elsinour by all vessels passing through the Sound from either the Baltic or the North sea. The custom-house, where these duties are paid, is a very fine building, and it is on account of this toll, that all nations trading in the Baltic keep a consul at Elsinour. The Sound dues are in proportion to the size of the ship and to the value of the cargo. They were originally a mere contribution to the expence of keeping light-houses on the coast.

The number of vessels of different nations that sailed through the Sound and paid the dues at Elsinour, was in

1768	-	-	-	6,30	vessels.
1778	-	-	-	8476	
1788	-	-	-	9224	
1792	-	-	-	12,114	
1798	-	-	-	19508	
1802	-	-	-	12,130	
1803	-	-	-	11,631	
1804	-	-	-	10,579	
1805	-	-	-	11,587	
1806	-	-	-	740	

And in the first three months of

1807	-	-	-	342	
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From which statement it appears, that the Baltic trade has been most considerable in the years 1792 and 1802, which both preceded the two late ruptures between England and France. See *SOUND*.

ELSNABBAN, a sea-port town of Sweden, in the province of Sudermania, on the coast of the Baltic; 32 miles E.N.E. of Nikioping.

ELSNER, JAMES, in *Biography*, a doctor of theology, was born, in 1692, at Saalfeld, in Prussia, and was destined by his father for trade, to which, however, he felt so strong a disinclination, that nothing could overcome it. He was accordingly sent to the university of Konigsberg, where he became private tutor to some young noblemen, and was afterwards appointed chaplain in the garrison to field-marshal count Alexander Von Dohm. He next went to Utrecht and Leyden, where he formed an intimacy with the most eminent literary characters of those cities. In the year 1719, he published a work on the delivery of the law on Mount Sinai, and shortly after the first volume of his "Sacred Observations on the New Testament." In the following year he left Holland, at the invitation of his Prussian majesty, by whom he was appointed professor of theology and the oriental languages at Lingen, having first taken his degree of doctor at Utrecht. From this place he was called to Berlin to restore the reputation of Joachim's school, which had fallen into much disrepute for want of proper discipline. Elsnor performed all that was required of him, and attained a high degree of respect, by the dignity and firmness of his manners. In the autumn of 1722, he pronounced an inaugural discourse on the obligation of uniting piety to learning; and immediately after this, he was chosen a member of the Royal Academy of Sciences. Other preferments were conferred upon him, and he was always very fully employed either as a preacher or an author; and, in 1742, he was appointed director of the class of the belles-lettres in the Royal Academy; and when the society was renewed in 1744, he retained the same office, and maintained the character which he had heretofore supported, as well by his attention to his academical duties, as by the learned dissertations with which he enriched the memoirs of the institution. He died of a fever on the eighth of October, 1750. His works are very numerous, and on various topics, but chiefly in theology. He published also, "A new description of the state of the Greek Christians in Turkey," in which he received very important assistance from Athanasius Dorostamos, who came to Berlin to collect money for the Christian slaves in England.

ELSTER, originally *Halfstrow*, in *Geography*, a small town of the kingdom of Saxony, in Upper Lusatia, on a river called the *Black Elster*, remarkable for its manufacture of knitted stockings.

ELSTERBERG, a small town of the kingdom of Saxony, in the circle of Voigtland, between some high hills on the river Elster, with an old ruined castle. It has a grammar-school, about 2000 inhabitants, and a flourishing manufacture of stuffs and woollen cloth.

ELSTERWERDA, a small town of the kingdom of Saxony, in the circle of Meissen, on the river Elster, with a fine hunting castle and a beautiful park. It has only 700 inhabitants; but is remarkable for a canal which was dug here in 1740, and by means of which it has a considerable timber trade to Meissen and Dresden.

ELSTOB, WILLIAM, in *Biography*, was born at Newcastle-upon-Tyne, in the year 1673. He was educated at Eton and Cambridge, but the latter place not being congenial to his health, he removed to Queen's college Oxford, where he was chosen fellow and tutor. In the year 1697, he took his degree of M. A., and in 1702 was appointed rector of the united parishes of St. Swithin and St. Mary Bothaw in London. He died in 1744, when he was only forty-one years of age. He published several works, and had collected materials for a history of Newcastle. He had likewise projected many literary designs, of which the most important,

important, was an edition of the Saxon laws, with great additions, together with notes of various learned men, and a prefatory history of the origin and progress of the English laws, down to the Conqueror and to Magna Charta. This great work was completed in 1721 by Dr. Wilkins, who deploras the loss which the literary world had sustained in the early death of Mr. Elstob. He intended also a translation, with notes, of Alfred's Paraphrastic Version of Orosius, of which his collections came into the possession of the late Dr. Teggé. This work was afterwards published by the Hon. Daines Barrington, with an English translation, who made use of Mr. Elstob's transcript. Biog. Brit.

ELSTOB, ELIZABETH, sister of the preceding, was attached to the same kind of pursuits, and was born at Newcastle in 1683. From a very early period she shewed a strong predilection for literary pursuits. She resided at Oxford during her brother's continuance at that university, and is described as having been the *indefessa comes* of his studies. She probably accompanied him to London, and assisted him in his antiquarian pursuits. To one of his publications, viz. the Homily on St. Gregory's day, she gave an English translation, and a preface in vindication of female learning. By the encouragement of Dr. Hickeys, she undertook a Saxon Homiliarium with an English translation, notes, and various readings, but only a few of the homilies were printed at Oxford in folio. In the year 1715, she published a "Saxon Grammar," the types for which had been cut at the expence of lord chief justice Parker, afterwards earl of Macclesfield. After the death of her brother, her circumstances were so very low, that she was reduced to the necessity of keeping a school at Evelham, in Worcester-shire. By the intercession of some friends, queen Caroline allowed her a pension of twenty guineas, which was paid very regularly till the death of that princess, when she was again reduced to great difficulties, and had recourse to education as a refuge from poverty. In 1739, she was received into the family of the duchess of Portland, where she continued till her death in the year 1756. Biog. Brit.

ELSYNGE, HENRY, was born at Battersea in 1598, and received his education at Westminster-school, and Christ-church college, Oxford. From the university he went to the continent, and spent seven years in foreign travel. Upon his return he was, through the interest of archbishop Laud, elected clerk of the house of commons, the duties of which office he performed with singular ability, and much credit. He acquired the esteem of all parties in the midst of much discord and faction, and kept his post under the long parliament till December 1648, when he chose to retire rather than take a part in the trial of the king. After this, he declined public business till his death in 1654. As an author his chief publication was entitled "The ancient Method and Manner of holding Parliaments in England." This was first printed in 1663. Anthony Wood supposed that it was chiefly transcribed from a MS. of the author's father, who was clerk of the house of lords, but there is no doubt it received many valuable additions from our author's own parliamentary experience. Mr. Elsyngé left a tract concerning proceedings in parliament, never published; and also other tracts and memorials. Biog. Brit.

ELTEN, in *Geography*, a small town of Germany, in the new kingdom of Westphalia, formerly a free imperial abbey, which was secularized at the peace of Lunéville, and given as an indemnity to the king of Prussia, who lost it again at the peace of Tilsit in July, 1807.

ELTERLEIN, a small town of the kingdom of Saxony, in the circle of the Ertzgebirge, situated between Annaberg and Grunhayn, with about 1000 inhabitants. It

is chiefly remarkable for the adjacent mines, which yield excellent magnesia and a very fine potters' clay for china. There is likewise a good manufacture of thread lace at Elterlein.

ELTHAM, a large village in the hundred of Blackheath and lathe of Sutton, in the county of Kent, England, consists of 256 houses, which are occupied by 1627 inhabitants. Its ancient name was Eald-ham, the old mansion or dwelling. John de Vesei, lord of Eltham, procured a grant of a market for this manor; and two other grants relating to it are extant among the records in the Tower. The market appears to have been discontinued in the time of James I., when the royal palace, the remains of which stand about two furlongs southward from the village, ceased to be visited by our kings.

Eltham palace was for several centuries a favourite retreat of the English sovereigns, to which, probably, its vicinity to the metropolis contributed, as well as the pleasantness of its situation. When it was originally built is unknown, yet it must have been prior to the year 1270, when Henry III. kept a grand public christmas here, accompanied by his queen and all the great men of the realm. In the next reign, Anthony Bec, the warlike bishop of Durham, obtained possession of it, and considerably improved it: he died here in 1311. Edward II. frequently resided here; and in the year 1315, his queen was delivered of a son in the palace, who was called John of Eltham, from the place of his birth. Edward III. held a parliament here in 1329, and another in 1375, when the Commons petitioned him to make his grandson, Richard de Bourdeaux, prince of Wales. Edward IV. was at a great expence in repairing the palace, where, in 1482, he kept his christmas in a very magnificent and costly manner, two thousand persons being daily fed at his charge. Most of the succeeding monarchs, to the time of Henry VIII., resided much in this palace; but on the rise of Greenwich it was gradually deserted. The change which it has undergone is exceedingly striking: formerly the abode of sovereigns, and the birth-place of princes, it is now a farm; and the beautiful great hall, where parliaments were held, and entertainments given in all the pomp of feudal grandeur, is now used as a barn for the housing and threshing of corn. The area, in which the buildings stand, is surrounded by a high stone wall, that has been partially repaired and strengthened by arches, &c. of brick, and a broad and deep moat, over which are two bridges, nearly opposite to each other, on the north and south sides. The hall is a most noble remain, measuring 100 feet in length, by 56 broad, and about 60 high. The windows have been extremely elegant, but are now bricked up. The roof is of timber, curiously wrought in the manner of that of Westminster-hall, and richly ornamented with finely carved pendants. Three parks, well provided with deer, were formerly connected with this palace: in the largest, which includes an area of two miles in circumference, stands a respectable mansion, called Eltham lodge. Haisted's History of Kent.

ELTMAN, a town of Germany, in the circle of Franconia, and bishopric of Wurzburg; 8 miles W.N.W. of Bamberg, and 40 E.N.E. of Wurzburg.

ELVAS, formerly *Jelves*, a town and bishop's see of Portugal, in the province of Alentejo, containing three parish churches, seven convents, two hospitals, and 12,500 inhabitants, including the district, in an open and fruitful territory, 18 leagues N.E. of Evora, and six W. of Badajoz, in Spain. It has a castle on an eminence, and is commanded by Fort la Lippe, a new and strong fortification on the top of a hill. Here is a remarkable aqueduct, supported

ported in some places by three arches one over the other; the streets are narrow, irregular, and dirty; and the houses are indifferently built. At some distance from the town the country is bleak and barren. N. lat.  $38^{\circ} 44'$ . W. long.  $7^{\circ}$ .

ELVÆ. See ELFS.

ELUDING, the act of evading, or rendering a thing vain, and of no effect: a dextrous getting clear, or escaping out of an affair, difficulty, embarrassment, or the like.

We say, to elude a proposition, &c. The design of chicanery is, to elude the force of the laws; this doctor has not resolved the difficulty, but eluded it. Alexander, says the historian, in cutting the Gordian knot, either eluded the oracle, or fulfilled it: "Ille nequicquam luctatus cum latentibus nodis, Nihil, inquit, interest, quomodo solvatur; gladioque ruptis omnibus loris, oraculi sortem, vel eludit vel implevit." Q. Curt. 13.

ELVEN, in *Geography*, a small town of France, in the department of Morbihan, chief place of a canton in the district of Vannes, with a population of 3829 individuals. The canton contains five communes and 9136 inhabitants, upon a territorial extent of 220 kilometres.

ELVERDINGHE, a small town of France, in the department of the Lys, chief place of a canton in the district of Ypres, with 2729 inhabitants. Its canton has a population of 9057 individuals dispersed in 9 communes, on a territorial extent of  $112\frac{1}{2}$  kilometres.

ELVERS, in *Ichthyology*, an English name for a small sort of eels, caught in some parts of the kingdom, particularly about Gloucester and Tewksbury. These are, in reality, young eelers, or sea-eels. They get up into rivers while very small, and as they precede the shads, it is conjectured that they supply them with food. They are taken in prodigious numbers in the rivers, in dark nights, by a kind of sieve made of hair-cloth, fixed to a long pole, and are esteemed a very delicate food. Willughby.

EL-VISO, in *Geography*, a well built town of Spain, in the province of New-Castile, and district of La Manche, containing a parish church, a convent, a palace of the marquis D'El-Viso, and 3500 inhabitants, about 20 leagues S.W. of Alcaraz; and 13 S.S.E. of Ciudad Real, situated in a fertile plain, producing corn, wine, and fruits.

ELVIUS; PETER, in *Biography*, was born at Upsal in 1710, and applied himself in early life to the study of mechanics, under able masters. In the year 1738, the royal college of Mines entrusted him with the care of its collection of machines. His own knowledge enabled him to construct a fulling mill on new principles. In 1743 he undertook, with M. O. Hamren, a tour through the kingdom of Sweden, to examine where the best situations could be obtained for works to be driven by water; and on this occasion he drew plans of those places which seemed most convenient for the purpose. For this service he obtained a place in the academy of Upsal, and applied himself to the calculation of chances and probabilities, which led him to consider the existing bills of mortality, and the means for rendering them more accurate and useful. He was a diligent observer of the heavens, and on the island of Huen searched out the ruins of the residence of Tycho Brahe, and made some celestial observations amidst the remains of Uraniburg. He died at the early age of 38, on the 27th of Sept. 1749, and the Academy of Sciences, to which he had been the secretary, caused a medal to be struck in honour of his memory. Gen. Biog.

ELUL, in *Chronology*, one of the Hebrew months, answering partly to our August and September. There are but nine and twenty days in it. It is the twelfth month

of the civil year, and the sixth of the ecclesiastical. Upon the seventh or ninth day of this month the Jews fast, in memory of what happened after the return of those who went to view the promised land. Numbers, xiii. xiv.

Upon the twenty-second of this month, the festival of the xylophori was observed, when wood was carried to the temple. Selden says, that it was celebrated on the eighteenth day of the month Ab. On the twenty-sixth of the same month, the dedication of the walls of Jerusalem by Nehemiah was commemorated. Joseph. lib. ii. cap. 17. p. 811. Nehem. xii. 27, &c. Calmet, Diction. Bibl.

ELVO, in *Geography*, a river of Italy, which runs into the Sesia, 2 miles N. of Vercelle.

ELUSA, in *Ancient Geography*, a town of Palestine, in Idumæa, W. of Jordan, according to Ptolemy. This town was once an episcopal city, and it is placed by P. Hardouin in the third Palestine.

ELUSA, called also *Eluse*, and *Civitas Elusatium*, a town of Gaul, was formerly the metropolis of Novempopulania, and maintained that rank till the eighth century. But upon its destruction by the Normans, the see of Auch was advanced to the rank of Metropolitan. Some remains of this place retain the name of Ciutat near Euse.

ELUSATES, the inhabitants of Elusa, who occupied the N.W. district of Armagnac. Cæsar mentions them, and places them between the Tarusates and the Garites.

ELUTRIATION, or *washing over*, is a method of separating substances of different specific gravities from each other by means of water. For this purpose the mixture is stirred about briskly in a vessel full of water, and when the heavier particles have again fallen to the bottom, the water, still turbid with the lighter ones that are as yet suspended, is poured off into another vessel, to the bottom of which they, in a short time, subside. By this simple method a skilful person will separate from each other three or four substances with great exactness.

ELUVIES, in *Geology*, is a term used by Mr. Parkinson, (*Organic Remains*, i. 275.) and some other writers, to express the supposed ruins of the antediluvian earth, effected by the Noachic deluge, but which it is presumed by others, from the Mosaic account of that miracle, did not destroy the existing vegetable productions or the fish, and much less therefore could it have effected the universal disintegration of mineral substances, on which Dr. Woodward's and some other theories are built. Besides, the animal and vegetable substances, which are found imbedded in the supposed post-diluvian strata, are none of them of the species, which, by the established modes of generation, have been handed down to us, immediately from those individuals of each species which Noah preserved in the ark, when the rest were drowned by the flood.

ELUXATIO, (from *eluxo*, to put out of joint,) a dislocation.

ELWAD-AD, in *Geography*, a town of Arabia, in the country of Yemen; about 40 miles nearly W. of Chamir. N. lat.  $16^{\circ} 16'$ . E. long.  $42^{\circ} 30'$ .

ELWALL, EDWARD, in *Biography*, was born at Sedgley, near Wolverhampton, in Staffordshire. At Wolverhampton he settled in business, and acquired the reputation of honesty and great integrity in his dealings. As a politician, he was distinguished as the zealous assertor of the civil and religious rights of the people, and as a vigorous supporter of the Hanoverian succession. He was of a serious and inquisitive turn of mind, and never hesitated to proclaim his sentiments on any subject that he deemed important. He considered the fourth commandment as binding on all generations, and not only wrote in defence of the opinion, but

while in business, constantly shut up his shop on the seventh day, and opened it on the first day of the week; hence he was stigmatized as a Jew. About the year 1714 he became distinguished as an Unitarian, and published "A true Testimony for God and his sacred Law, being a Defence of the first Commandment of God, against all Trinitarians under Heaven." This drew on him the resentment of the neighbouring clergy, who ceased not to pursue him with their enmity, till they procured an indictment against him for heresy and blasphemy; on which he was tried, without having had a copy of his indictment, before judge Denton about the year 1726, at Stafford assizes. He pleaded his own cause, and vindicated the principles which he had embraced with a firmness and presence of mind, said to have been rarely equalled in modern times, and with complete success, for a respectable and honest jury, under the direction of an upright judge, acquitted him. Mr. Elwall was not daunted by the obloquy and prosecution which his first piece had drawn on him from defending with freedom the sentiments for which he had suffered, but published several other tracts, having the same tendency. After his trial he removed to London, and became a member of the seventh-day Baptist church at Mill-yard, Goodman's fields. In the latter part of his life he frequently attended the religious assemblies of the quakers, and was sometimes admitted to speak among them. He died in London at an advanced age, with an unspotted reputation, about the year 1745. He had not enjoyed the advantages of a learned education; but his natural abilities, and good judgment, were such as rendered his conversation agreeable to persons in the higher ranks of society, by whom he was known, and respected, on account of his ardent attachment to the house of Hanover. Speaking of himself, his principles, and conduct, he says, "I have been a sturdy and strenuous friend to my royal friend George these forty years and upwards, ever since the nation happily settled the crown in his illustrious family; and many a stately Jacobite and Tory have I silenced by dint of argument, and brought to the ground by dint of fist, yet generally in self-defence, and not to convince his judgment." He was a man of inflexible integrity and of extensive charity, as well as of fervent piety.

ELWANGEN, in *Geography*, a small town of the kingdom of Wurtemberg, 18 miles S.E. of Halle, in Suabia, and 30 S.W. of Anspach. It was formerly a rich abbey of the German empire, whose prelate ranked as a prince, and voted in the college of princes. At the peace of Lunéville it was given to Wurtemberg as an indemnity for the territory which its sovereign was forced to cede to France on the western shore of the Rhine.

ELWY, Britain, the name of two rivers in Wales, one rising near Gwythrin, in the west part of Denbighshire, in North Wales, runs eastward for some miles, then suddenly turning northward above St. Asaph, passes by that city, and falls into the Clwyd, about three miles below it. Another river of the same name rises in the mountains to the northward of Capelton Ybedyddier, in Glamorganshire, South Wales; and running in a south-easterly direction passes Hensfall park, St. Fagan's, &c. and meeting the Taf, at the Embochure, near Penarth-point, forms Penarth harbour.

ELXAI, in *Biography*. See ELCESAITES.

ELY, ISLE of, in *Geography*, a tract of land so called, is situated in the northern part of Cambridgeshire, England, and was formerly surrounded by waters; but, in consequence of the vast improvements made by draining the fens, &c. it is now merely known by the name of an island. The whole district, called the isle of Ely, extends from the

bridge at Tyd on the north, to Upwere on the south, 28 miles in length; and from Abbot's or Bishop's Delf on the east, to the river Nene, near Peterborough, on the west, 25 miles in breadth: and includes several considerable towns and villages, of these the principal place is.

ELY, which, though far from populous, claims, as being the see of a bishop, the appellation of a city. It is situated on a small eminence near the river Ouse, and owes its origin to the establishment of a monastery here, A.D. 673, by Etheldreda, daughter of Anna, king of East-Anglia. After her death, in 679, the government of the abbey successively devolved on her sister Sexburga, queen of Kent; Ermenilda, queen of Mercia, daughter of Sexburga, and the princess Werburga, her grand-daughter, all of whom were, with the foundress, for many centuries considered as saints. A town gradually arose about the monastery; and both remained in peace and security till the year 870, when this place of monastic retirement was discovered by the Danes, who invaded the isle, and, though at first repulsed by the bravery of the inhabitants, returned in greater numbers, and overcame every defensive effort. They put the religious to the sword, set fire to the church and other buildings, and departed, loaded with the spoil, not only of the town and monastery, but also of all the neighbouring places, whose inhabitants had deposited their valuables here for better security. Some of the inmates of the monastery, who had escaped the massacre by flight, returned a few years afterwards, and commenced a college for secular clergy, which continued till 970, when the monastery was restored to its former establishment by Ethelwold, bishop of Winchester, under the patronage of king Edgar, who, in consideration of a large sum paid by the bishop, gave up to the convent the jurisdiction of the isle, which after the Danish massacre had been annexed to the crown. Bishop Ethelwold bestowed large benefactions on the abbey, which now consisted of regular monks of the order of St. Augustine. Brithnoth, the first abbot, exerted himself to complete the repairs of the church. The abbey continued to prosper till the conquest: its privileges being previously augmented and confirmed by Canute, and again by Edward the Confessor, the latter of whom had received his education within its walls. During the confusion which ensued on the Norman invasion, the abbey was deprived of many estates; and Thurstan the abbot, fearing that its whole possessions would be seized by the Conqueror, resolved to support the interest of Edgar Atheling, in which he was joined by several English nobles, who were determined to defend their country from the dominion of William, whom they regarded as an usurper. A vigorous, and, for some time, effectual resistance was made; but at length, the abbot having seceded from the confederacy, the superior prowess of the Norman soldiers prevailed. Great numbers of the English were slain in battle; and many of those, who were made prisoners, were cruelly mutilated; some having their eyes put out, and others their hands and feet cut off, that they might remain living monuments of the Conqueror's vengeance, and become a terror to such as disputed his authority.

A bishop's see was established here in 1107, and Henry, bishop of Bangor, was appointed the first diocesan. This prelate procured many gifts and privileges for his bishopric, and a grant of a fair for the city, to continue for seven days. The king granted a mandate to make an equal division of the abbey estates, between the prelate and the abbot, but the former contrived to retain a full third of the possessions more than he was entitled to. On the surrender of the monastery to Henry VIII. that monarch granted his letter-patent, dated September 10, 1541, to convert the convent

tual church into a cathedral, by the title of the Cathedral Church of the Undivided Trinity; the establishment for the performance of divine service to consist of a dean, a priest, and eight prebendaries, with other ministers: the dean and prebendaries to form a body corporate. The bishop of Ely possesses the rights of a lord of a county palatine, and is sovereign within the isle, where all causes are heard and determined by a judge of his appointing, who holds assizes, gaol delivery, and quarter sessions.

The cathedral is the workmanship of very different periods, and displays a singular admixture of the Saxon, Norman, and English styles of architecture; yet, notwithstanding the dissimilarity of its parts, it must, when considered as a whole, be regarded as a very magnificent structure. The north and south transepts, which are the oldest parts, were erected in the reigns of William Rufus and Henry I. Here the arches are semi-circular, as well as in the nave, which was begun in the reign of the latter monarch, and completed before 1174. Between this period and the year 1189, bishop Rydel erected the great tower at the west end, which was anciently flanked on the north side by a building of the same kind as that on the south: but this either fell or was taken down, and another building begun in its place. This was never carried higher than 12 or 14 feet. The interior view of this tower is particularly beautiful, it being decorated with small columns and arches running round in several stories, and lighted by 27 windows. The lower part was repaired, and new cased with stone, in the middle of the 15th century. The handsome vestibule at the entrance, formerly called the Galilee, was built about the year 1200, by bishop Eustachius. The foundation of the elegant structure which was originally the presbytery, but now forms the choir, was laid by Hugh Northwold, the eighth bishop, in the year 1234, and finished in 1250. The three most western arches were destroyed by the fall of the lofty central tower, in the night of the 12th of February, 1322. To prevent the recurrence of a like accident, Alan de Walsingham, sub-prior of the convent, and sacrist of the church, a person eminently skilled in architecture, designed and erected the present magnificent octagon, which is supported on eight pillars, and terminated by a lantern. The capitals of the pillars are ornamented with historical carvings, representing the principal events in the life of Etheldreda. This octagon is probably unequalled by any of the kind: the stone work was completed in six years, and the wood work raised thereon, and covered with lead, in about 15 years. The whole was perfected in the year 1342, at the expence of 240*l.* 4*s.* 11*d.* The three arches eastward of the octagon were rebuilt about the same period, by bishop Hotham, and are very much embellished. At the east end of the north aisle is a sumptuous chapel, erected by bishop Alcock, who died at his castle at Wisbech, in 1500. His tomb, with his effigy lying thereon, but much defaced, is placed under an arch of stone on the north side. In the south aisle, and in some respects corresponding with the former, but much superior in its embellishments, is another chapel, which was erected by bishop West, about the year 1530, and is highly enriched with ornaments and elegant tracery, &c. Both these chapels were greatly dilapidated by the enthusiastic reformers who sprung up during the civil wars, and seem to have had an invincible antipathy to every religious edifice that displayed taste and elegance.

The extreme extent of the cathedral, from east to west, is 535 feet; but the interior length is only 517. The length of the transept is 190 feet, the height of the lantern over, 170. The extreme height of the western tower

270, and the tower on the south wing of the latter 120. The length of the nave is 203 feet, and the height of the roof over it 104. The height of the eastern front to the top of the cross is 112 feet. Near the east end of the cathedral, on the north side, is St. Mary's chapel, now Trinity church; it having been assigned to the use of the inhabitants of that parish soon after the Restoration, by the dean and chapter. This elegant structure was commenced in the reign of Edward II. and is one of the most perfect buildings of that age. The shape is an oblong square; the interior length being 200 feet, the breadth 46, and the height of the vaulted roof 60. This building has neither pillars nor side aisles, but is supported by strong buttresses, surmounted with pinnacles. The spaces over the east and west windows were formerly decorated with statues, and a variety of well-executed sculpture: and the interior was embellished with niches highly carved, and enriched with statues, ornamental foliage, and flower-work. This edifice was built at the charge of the convent by John de Wisbech, one of the monks, and Alan de Walsingham, who erected the octagon. The first stone was laid by the latter on Lady-day, 1321. The cloisters, and other buildings belonging to the monastery, have been long since demolished; with the exception of the refectory, which has been converted into the deanery; and an elegant little chapel built by prior Crauden, now used as a granary, adjoining to it.

The principal charitable benefaction for the use of the poor of Ely is vested in the churchwardens, and arises from estates in the neighbourhood, bequeathed by — Parson, about the year 1425. Here is also a free-school, supported by the dean and chapter; and a charity-school for twenty-four boys, who are educated and clothed by the income of an estate bequeathed by Mrs. Needham about 1740. The police of Ely is regulated by the magistrates, who are appointed by the bishop, and are justices of the peace within the isle. These meet for the dispatch of business every market-day, which was altered in 1802 from Saturday to Thursday. This city is the only one in England not represented in parliament. Many of the houses are of stone, and some of them have an ancient appearance. The streets are irregular, and, with the exception of the principal one, neither lighted nor paved. The population, as ascertained under the late act, was 3713; the number of houses about 700. The chief employment of the inhabitants is gardening, which is carried on in this neighbourhood to a great extent. Cambridge, St. Ives, and even London, receive considerable supplies of vegetables from this place. Great quantities of strawberries are also reared here, and some other fruits; but these are chiefly conveyed in barges to Lynn, and carried thence by the vessels employed in the coal trade to Newcastle-upon-Tyne, and other places in the north of England.

The Rev. James Bentham, author of "The History and Antiquities of the conventual and cathedral church of Ely," was a native of this city. Some account of this gentleman has already appeared in this work. (See BENTHAM.) An interesting and well written account of Ely cathedral has recently been published by the Rev. Mr. Miller, of this place. See also Lysons's *Magna Britannia*, vol. ii.

About one mile from Ely is Tatterfall-hall, which derived its name from the late Mr. Tatterfall, of sporting memory, and is now possessed by his son.

ELY, *Elie*, or *Ellie*, a parish of Fifeshire, in Scotland, within which is an ancient royal borough of the same name. This is situated close to the sea, on the southern shore of the Frith of Forth, where there is an excellent harbour, much resorted to by "wind-bound vessels." Seven square-

square-rigged vessels, carrying 1000 or 1100 tons, belong to it, and are employed in foreign trade. Vessels of large size are built here; and in the town are some manufactories for checks, bed-ticks, and ropes. Near the shore rubies have been discovered. Contiguous to the town, in the face of Kinraig rocks, is the cave of Mac-Duff, in which it is related that Mac-Duff retreated from Macbeth and his followers. Malcolm granted many privileges to this town. Sinclair's statistical Account of Scotland.

ELYMAIS, in *Ancient Geography*, or, as it is called by Strabo, *Elymatis*, a province of Persia, lying between the rivers Eulæus and Oroates, and extending from the confines of Media to the Erythræan sea, or Persian gulf. It was formerly divided into three great districts, viz. Mesabatene, Gabene or Gabiene, and Carbiana, and containing the following cities, viz. Seleucia or Soluce, on the banks of the Hedypos or Hedyppus, which Strabo calls a great city, Safirate, at a small distance from mount Calyrus, Badaca, on the Eulæus, and Elymais, the metropolis of the province, famous for a rich temple consecrated to Diana, which Antiochus Epiphanes attempted to plunder, but he was obliged by the inhabitants to retire in disgrace to Media. This temple was afterwards plundered by one of the Parthian kings, who found in it, as we are informed by Strabo, 10,000 talents. In this country there was also a very rich temple consecrated to Jupiter Belus, which Antiochus the Great attempted to plunder, but lost his life in the attempt. The country of Elymais was inhabited, according to Pliny, by the following nations, viz. the Oxii, or Uxii, Mizæi, Parthusi, Mardi, Saitæ, Hyi, Cossæi, Parataceni, and Messabatæ. The Elymæans were a powerful people, inured to the toils of war, skilful bowmen, and never subdued either by the Syro-Macedonian, or Parthian kings, but governed by their own princes. If we may depend upon the authority of Strabo, the rise of this kingdom may be dated from the downfall of the Persian monarchy, for the ancients are agreed that the Elymæans were subject to the kings of Persia; and if they never submitted to the Syrian yoke, they must have been first governed by their own princes, either in Alexander's life-time, or soon after his death. Nothing is known of their kings, but that they assisted Antiochus the Great in his wars with Rome, but afterwards cut him off in defence of their temple. They afterwards engaged, under the conduct of their king, in a war against the Babylonians and Susians, in which they were assisted by the Cossæans with 13,000 archers.

ELYMAIS is also a name given by some writers to the city of Persepolis.

ELYMI, or HELYMI, a people who inhabited the N.W. part of Sicily, about the river Crimisa, where were situated the towns of Ægesta or Acasta, Erice and Entella.

ELYMIA, a town of Greece, in the Peloponnesus, placed by Xenophon towards the towns of Mantinea and Orchemene.

ELYMIOTÆ, a people of Macedonia, who occupied a plain almost surrounded by mountains, towards the source of the river Aliacmen, according to Ptolemy. They had to the N. W. the country of the Lyncestes, to the N. E. Emathia, to the S. E. the Pelasgiotide, and to the S. W. Pelagonia.

ELYMNIUM, one of the names of the island of Eubœa.—Also, a town of Macedonia, on mount Athos.

ELYMUS, in *Agriculture*, a term signifying lime-grass, a genus of grasses which are of but little use to the farmer, except in protecting the loose sandy banks on the sea-shores, in different parts of the island; and for which purpose the following sort is the most useful.

ELYMUS *Arenarius*, sea lime-grass, which is a kind of grass that, with the sea reed, helps very much, according to the opinion of Mr. Sole, to sustain and keep up the loose sand-banks on the borders of the sea, from the destructive effects of the tides.

ELYMUS, in *Botany*, ελυμος; of Dioscorides, from ελυω, to fold up, alluding to the sheath which incloses the spike or ear of some species. This etymology applies at least to the Millet or Panick, supposed to be the ancient ελυμος; but Linnæus has adopted the name for a new genus of his own, akin to *Hordeum* and *Triticum*, to which it is less suitable. Linn. Gen. 39. Schreb. 54. Willd. Sp. Pl. v. 1. 467. Juss. 31. Sm. Fl. Brit. 152. Mart. Mill. Dict. v. 2. Class and order, *Triandria Digynia*. Nat. Ord. *Gramina*.

Gen. Ch. *Cal.* Common receptacle elongated into a spike. Perianth lateral, aggregate, consisting of two lanceolate glumes to each spikelet. *Cor.* of two valves; the outer one largest, pointed, awned; the inner concave, emarginate, finely fringed. Nectary a pair of oblong, acute, fringed scales. *Stam.* Filaments three, capillary, very short; anthers oblong, cloven at the base. *Pist.* Germen turbinate; styles two, divaricated, short; stigmas feathery. *Peric.* none, except the permanent corolla. *Seed* solitary, linear, convex at the back, concealed by the glumes.

Ess. Ch. Calyx lateral, aggregate, of two valves, containing many florets.

A genus of large coarse rigid grasses, for the most part perennial, with long creeping roots. This last quality renders the *E. arenarius*, Linn. Sp. Pl. 122. Sm. Engl. Bot. t. 1672. Knapp. t. 108, particularly valuable, as forming a natural barrier, in the loose blowing sand of many sea shores, to the encroachments of the ocean, being indeed one of the principal means by which the industrious Hollanders have gained a part of their territories from the sea. It is in England comprehended with *Arundo arenaria* and *Carex arenaria*, (see those articles,) under the name of Marram, and acts of parliament have been made for their preservation. The roots and leaves of such grasses being very durable, retain the blowing sand, of which they accumulate more and more as they extend in growth upward, and thus gradually form a natural and very firm bank. In a clay soil they are of no avail. Of the economy of the American or Siberian species of *Elymus*, we have no information. Two annual European species, *E. Caput-Meduse* and *E. Hystricæ*, are furnished with very long rough capillary awns, by which their seeds are not only wafted to a distance, but detained by the accumulation of blowing sand, when they have once alighted, till they can fix themselves by roots.

ELYOT, Sir THOMAS, in *Biography*, a gentleman eminent in various branches of learning, and a patron and friend of most of the learned men in the reign of Henry VIII., was descended of a good family in the county of Suffolk, and son of Sir Richard Elyot. He was educated at St. Mary's Hall, in Oxford, where he made a great progress in logic and philology; but the year in which he entered (like the year of his birth) is not certainly known; it is, however, supposed to have been about the year 1514. After he had spent some years at the university, he travelled into foreign countries, and, on his return, was introduced at court. His uncommon genius and extensive learning recommending him to the favour of Henry VIII., who was a great patron of men of letters, his majesty conferred upon him the honour of knighthood, and employed him in several embassies. He sent him, particularly, to Rome in the year 1532, on the subject of the divorce of

queen Catharine, and afterwards to the emperor Charles V. in the year 1536. Elyot was, as Wood observes (see his *Athen. Oxon.*) an excellent grammarian, poet, rhetorician, philosopher, physician, cosmographer, and historian; and was distinguished as much for his candour, and for the innocence and integrity of his life, as for his accomplishments. He was admired and beloved by all the men of learning who were his contemporaries, and his memory is celebrated by them in their respective works, particularly by Leland, in his "Encomia Eruditorum Virorum." He was buried on the 25th of March 1546, in the church of Carleton, in Cambridgeshire, of which county he had been sheriff; and a monument was soon after erected over his grave. He possessed several manors in Cambridgeshire, and one or more in Hampshire.

He wrote and translated several works. 1. "The Casket of Health," which is said to have been first published in 1541; but Dr. Aikin observes, that his edition of that year is asserted to be "corrected, and in some places augmented, by the first author thereof." It was reprinted in 1572, 1580, and 1595. The reading of the author, as it appears from his *proleme*, or preface, was unusually great, considering that he did not follow the profession of physic, having extended to the works of all the Greek, Arabian, and Roman writers of credit. This book was greatly esteemed, not only by the public in general, but by some of the faculty in his time, and is, indeed, fully as worthy of notice as most of the medical pieces of that age. His rules for diet and regimen, when not drawn from Galenical theory, are on the whole founded upon plain good sense; and he uniformly inculcates temperance of every kind. This he carries to a degree, with regard to certain enjoyments, that would no doubt be generally thought somewhat too rigorous, except by such a bridegroom as the old gentleman in La Fontaine, who would be pleased with our knight's authority to add all the months, from April to October, to the red letter days of his calendar.

We learn from the work in question, that the disease now called a *cold*, began to be common in England in the time of Elyot. "At this present time," he says, "in this realm of England, there is not any one more annoyance to the health of man's body, than distillations from the head, called rheums." The cause of their being so much more frequent than they used to be forty years before, he supposes to be "banquettings after supper, and drinking much, especially wine, a little after sleep;" and also covering up the head too hot, a practice which prevailed to such a degree, that he tells us, "now a days, if a boy of seven years of age, or a young man of twenty years, have not two caps on his head, he and his friends will think that he may not continue in health; and yet if the inner cap be not of velvet or satin, a serving man feareth to lose his credence."

The other works published by sir Thomas Elyot, were, 2. "The Governor," in three books, 1544, 8vo.; 3. "Of the Education of Children;" 4. "Banquet of Sapience;" 5. "Prefervative against the Fear of Death;" 6. "De rebus memorabilibus Angliæ;" 7. "An Apology for Good Women;" 8. "Bibliotheca Eliotæ, or Elyot's Library or Dictionary," 1541, folio; which work was afterwards augmented and improved by Cooper. He translated also from the Greek into English, "The Image of Governace, compiled of the Arts and Sciences, by the Emperor Alexander Severus," 1556, 8vo.; and from the Latin into English, "St. Cyprian's Sermons of the Mortality of Man," 1534, 8vo.; and, "The Rule of a Christian Life," written by Picus, earl of Mirandula, printed in the same year.

(Gen. Biog. Dict. Aikin's Biog. Memoirs of Med. in Great Britain.)

ELYRUS, in *Ancient Geography*, a town of the island of Crete, which, according to Pausanias, was situated in the mountains.

ELYS BAY, in *Geography*, a bay of the island of Antigua, on the N. coast, a little to the south of Beggar's Point.

ELYSII, in *Ancient Geography*, a people who inhabited the eastern part of Germany.

ELYSIUM, ΕΛΥΣΙΟΝ, in the *Ancient Theology*, or rather *Mythology*, a place in the inferi, i. e. in the lower world, or, as we sometimes render it, in hell; furnished with fields, meads, agreeable woods, groves, shades, rivers, &c. whether the souls of good people were supposed to go after this life.

Orpheus, Hercules, and Æneas, are supposed to have descended into elysium, in their life-time, and to have returned again. Virgil. lib. vi. ver. 638, &c. Tibullus, lib. i. eleg. 3. gives us fine descriptions of the-elysian fields.

Virgil opposes elysium to tartara; which was the place where the wicked underwent their punishment.

"Heic locus est, partes ubi se via findit in ambas:  
Dextera, quæ Ditis magni sub mœnia tendit:  
Hac iter elysium nobis: at læva malorum  
Exercet pœnas, et ad impia tartara mittit."

He assigns elysium to those who died for their country, to those of pure lives, to truly inspired poets, to the inventors of arts, and to all who have done good to mankind.

Some authors take the fable of elysium to have been borrowed from the Phœnicians; as imagining the name elysium formed from the Phœnician ἕλυ, *alaz*, or ἄλυ, *alats*, or ὄλυ, *alas*, to rejoice, or to be in joy; the letter a being only changed into e, as we find done in many other names; as in *Enakim*, for *Anakim*, &c. On which footing, elysian fields should signify the same thing as a place of pleasure; or,

"— Locos lætos, & amœna vireta  
Fortunatorum nemorum, sedesque beatas." Virg.

Others derive the word from the Greek λυω, *solvo*, I deliver, I let loose, or disengage, because here men's souls are freed, or disencumbered from the fetters of the body. Be-roaldus and Hornius, Hist. Philosoph. lib. iii. cap. 2. take the place to have derived its name from Eliza, one of the first persons who came into Greece after the deluge, and the author and father of the Ætolians. According to Diodorus Siculus (l. i. c. 36.) the whole fable of the infernal regions was borrowed from the funeral rites of the Egyptians, and introduced into Greece by Orpheus. Hence Homer is said to have borrowed his ideas and descriptions, which occur in various parts of the *Odyssey*. Accordingly in the fourth book he gives the following account of elysium in the address of Proteus to Menelaus:

"Elysium shall be thine; the blissful plains  
Of utmost earth, where Rhadamanthus reigns.  
Joys ever young, unmix'd with pain or fear,  
Fill the whole circle of th' eternal year:  
Stern winter smiles on that auspicious clime:  
The fields are florid with unfading prime:  
From the bleak pole no winds inclement blow,  
Mold the round hail, or flake the sleecy snow.  
But from the breezy deep, the best inhale,  
'The fragrant murmurs of the western gale."

Pope's Od. b. iv. v. 765, &c.

The other poets as well as the philosophers seem to have copied their notions of hell and of the elysian fields from Homer. Plato, in his account of the state of departed spirits, represents the soul of the deceased as passing into a place, which he calls divine, and as being there judged. If his life was conformable to the right of reason, he is advanced to a higher apartment, where he enjoys pleasure and prosperity in the society of the gods; whilst the souls of bad men sink into a noisome abyss, there to dwell in thick darkness, and to endure every kind of misery. Socrates also adopted similar ideas. This philosopher distinguished a three-fold state of souls departed. Those who had neither singular merit nor enormous vices, inhabited the confines of Acherusia, where, being purified by the waters of the lake, they received the rewards of the few virtues they had practised. The souls of the wicked wandered about their tombs, where they were tormented in different ways. After which, having drunk the water of Lethe, they entered into new bodies, more or less honourable, according to their merit. The souls of the good went immediately into the elysian fields. Pythagoras maintained, that the soul, upon its immediate separation from the body, was conducted by Mercury into a place of the purest air, in which were the elysian fields, called by Virgil the "aerial regions," *aerios campos*. The souls of the philosophers, which were the best of all, became like to the gods, while those of the wicked were tormented by the furies without intermission. Both the one and the other, after a certain period of purification, returned to the earth to animate new bodies. Thus did this philosopher inculcate, first in Europe, the doctrine of the metempsychosis, or transmigration of souls, which he is said to have borrowed from the Egyptians, and which had been taught before by Orpheus and Homer, who had borrowed it from the same people. Accordingly we learn from Herodotus, that the Egyptian priests maintained, that the soul does not die with the body, but is received into Amenthes, which was a place under ground, resembling the hell of the Greek poets. Plutarch says, that this word denotes "that which gives, and that which receives," and adds, that it was a place in the centre of the earth, the common receptacle of departed souls. Hence, after a certain period, they were released, and united to new bodies. The poets have delivered sentiments similar to those of the philosophers concerning the state of souls after death, and whilst each had his peculiar notions, all agreed, that the soul goes either to Elysium or Tartarus; though they are far from being unanimous as to the situation of these two mansions. Some place the elysian fields in the middle region of the air; some in the moon; others in the sun; and others again in the centre of the earth adjoining to Tartarus. The most common opinion is, that they lay in one of the isles of the ocean, called the "Fortunate islands," which are reckoned to be the Canaries. According to Ol. Rudbecks the elysian fields were situated in Sweden. In the opinion of many of the ancients, the mansion of the blessed was in the charming country of Betica (the present Andalusia in the extremity of Spain towards Cadiz,) whither the Phœnicians had travelled from the earliest times, and which was represented as a delicious country, possessing a fertile soil, abounding with enchanted groves, enriched by mines of gold and silver, and watered with rivers, streams, and fountains. According to Homer, the infernal regions were in the country of the Cimmerians, who are said to have inhabited the western coasts of Italy, near Baiæ and Puteoli, where Ulysses arrives on the same day that he takes his leave of Circe. Virgil has adopted Homer's notion, and places the mouth of hell upon the same coast, near the lake

Avernus. Others, however, of the poets, place the entrance of hell at the promontory of Tenarus, where was the cave from which Hercules dragged Cerberus when he went down to hell. Others seek for it in Thesprotia, and Lucan refers it to the banks of the Euphrates. The ancients differ in opinion with respect to the time, during which departed souls continued in the infernal regions. Some suppose that souls doomed to Tartarus continued there a thousand years, before the period of their transmigration commenced. Pindar fixed the residence of the blessed in the elysian fields for ever; whence, according to Virgil and the other poets, they were to depart after a certain period of time, having drunk the water of oblivion; and this period was usually limited to a thousand years. (See TARTARUS.) The poets, Homer, Virgil, Pindar, Claudian, Catullus, &c. describe the regions of bliss under a variety of pleasing images, such as green bowers, gliding streams, murmuring springs, charming meadows, serene air, perpetual springs, warbling birds, &c. Tibullus, whose imagination was voluptuous, represents it as abounding with mirth and all sensual pleasures. Virgil admits merely chaste and innocent enjoyments, and in this respect he has copied Homer.

ELYTROCELE, (from *ελτρος*, the *vagina*, and *κληνη*, a *tumour*;) in *Surgery*, a hernia in the yagina.

ELYTROID, in *Anatomy*, from *ελυτρον*, a *sheath*, and *ειδος*, *form*, is a name applied to one of the coverings of the testicle. See GENERATION, *Organs of*.

ELYTRON, properly a covering of any sort, and for any substance. Hippocrates has appropriated the word to signify the membranes which involve the spinal marrow.

ELZEVIRS, in *Biography*, celebrated printers at Amsterdam and Leyden, lay claim to a short notice in this work, on account of the many valuable books which were printed at their presses, and of the perfection to which they carried their art at a comparatively early period. The first of the family was Lewis, who was distinguished for his editions from the year 1595. He was succeeded by Bonaventure, Abraham, and Daniel, of whom the last died about the year 1680. The small types of these famous printers have a clearness and elegance which have rarely been equalled. Virgil, Terence, and the Greek Testament, printed in 1633, distinguished by characters in red ink, are reckoned master-pieces; and the best of their classics still maintain a high value. Moreri.

ELZT, or ELTZ, in *Geography*, a town of Germany, in the country of Lower Saxony, and bishopric of Hildesheim on the Saale; 9 miles S.W. of Hildesheim.

EM, or EMBAK, a river of Russia, in the government of Riga or Livonia, which issues from the lake Wyrzt, and falls into the Peipus.

EMANATION, formed of the Latin *e*, out of, and *manare*, to flow or stream, the act of flowing, or proceeding, from some source or origin. Such is the emanation of light from the sun; or that of effluvia from odorous, &c. bodies; of wisdom from God, &c.

The principle of emanation was adopted from the most remote times by the oriental philosophers, and by means of emanation from an eternal fountain of being, they endeavoured to explain the nature and origin of things. Zoroaster, at an early period, maintained this system, alleging, that various orders of spiritual beings, gods or demons, have proceeded from the deity, which are more or less perfect, as they are at a greater or less distance, in the course of emanation, from the eternal fountain of intelligence; among which, the human soul is a particle of divine light which will return to its source, and partake of its immortality; and matter is the last or most distant emanation from  
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the first source of being, which, on account of its distance from the fountain of light, becomes opaque and inert, and whilst it remains in this state is the cause of evil: but, being gradually refined, it will at length return to the fountain whence it flowed. This doctrine of emanation afterwards produced many fanciful opinions in theology. It was adopted by the ancient Indians, and taught under various modifications by the Brachmans. The same system was likewise received among the Egyptians, taught by Orpheus and Pythagoras, and communicated to the Greeks either from Egypt or from the East. Wherever it originated, it was taught for many successive ages in the more civilized regions of Asia and Africa, and both before and after the commencement of the Christian era, it gradually spread through the Alexandrian, Jewish, and Christian schools. It was a distinguishing tenet of the Jewish Cabbala, of Simon Magus, and of the Gnostics and modern Platonists. This system, as it was taught by the oriental, Alexandrian, and Cabbalistic philosophers, comprehended the following tenets. All things are derived, by emanation, from one principle; which principle is God. From him a substantial power immediately proceeds, which is the image of God, and the source of all subsequent emanations. This second principle sends forth, by the energy of emanation, other natures, which are more or less perfect, according to their different degrees of distance, in the scale of emanation, from the first source of existence, and which constitute different worlds, or orders of being, all united to the eternal power from which they proceed. Matter is nothing more than the most remote effect of the emanative energy of the Deity. The material world receives its form from the immediate agency of powers far beneath the first source of being, and is the necessary effect of the imperfections of matter. Human souls are distant emanations from Deity; and, after they are liberated from their material vehicles, will return, through various stages of purification, to the fountain whence they first proceeded. Nothing can be more fanciful than the numerous fictions which are blended in this system, and which have been grafted upon it by enthusiasts of different descriptions, both philosophical and theological; inasmuch that it has been the soul of enthusiasm and fanaticism. (See THEOSOPHISTS.) Some of the modern Eclectic philosophers attempted to unite the atomic and emanative systems; and Jordano Bruno, in particular, founded his doctrine on the ancient system of emanation. See BRUNO.

EMANATION is also used for the thing that proceeds, as well as the act of proceeding. The power given a judge is an emanation from the regal power; the reasonable soul is an emanation from the divinity.

EMANATION is also used among the schoolmen, for the production of a lesser thing, in order to the production of a greater, by virtue of some natural connection, or dependence between them.

Hence that is called an emanative cause (in contradistinction to an efficient cause) which produces an effect by its mere presence, without the intervention of any action; as a rose doth a smell, &c. Others, and with good reason, deny that there is any such thing as an emanative cause, to produce an effect without any action. See CAUSE.

EMANCIPATION, formed from the Latin *ex*, of, and *mancipium*, a slave, in the Roman Law, was the act of setting a son free from the power and subjection of his father.

Emancipation differs from manumission, as the latter was the act of a master in favour of a slave, the former that of a father in favour of his son.

The effect of emancipation was, that the goods, and

moveable effects, which the son should thenceforth acquire, should be his sole property, and not the property of his father, as they were before emancipation. Besides, emancipation put the son in a capacity of managing his own affairs, and of marrying without his father's consent, though a minor, or pupil, and under twenty-five years of age.

There were two kinds of emancipation; the one *tacit*, which was by the son's being promoted to some dignity, or by his coming of age, or by marriage; in all which cases, the son became his own master of course.

The other *express*, where the father declared before the judge, that he emancipated his son. This was not performed without some formality: the father was first to sell his son imaginarily to another man, whom the lawyers call *pater fiduciarius*, father in trust; of whom being bought back again by the natural father, he manumitted, or set him free, by a declaration before the judge. This imaginary sale was called *mancipatio*; and the manumission consequent thereon, emancipation.

Emancipation obtained in France, chiefly with regard to minors, or pupils, who were hereby set at liberty to manage their effects, without the advice, or direction, of their fathers or tutors. It must be observed, however, that emancipation only extended to the selling of moveables, and letting of leases, &c. of immoveables; not to the selling or mortgaging of immoveables; which were only done with the consent of a curator, ordinarily a person appointed, when emancipated.

Formerly emancipation was performed in the ordinary courts of justice, when desired by the child; but if he were a minor, the king's letter was also required. Though there were other ways of emancipation, as by marriage; arriving at the age of twenty years; and in some provinces by the death of the mother, because the children were there under the power of the father and mother conjointly; so that the death of either of them emancipated the child.

Emancipation by marriage, in France, gave a power of marrying again, without the father's consent though under age; but among the Romans, Cujas tells us, a widow, under twenty-five years of age, though emancipated by her former marriage, returned into the power of the father, and might not marry a second time, without his consent.

Du-Cange observes, that the word emancipation was also used in the monasteries, in speaking of monks promoted to any dignity, or removed from under the power of their superiors; as also in speaking of monasteries, chapels, &c. themselves, when exempted by the pope, from the jurisdiction of the ordinary.

EMANUEL, in *Biography*, king of Portugal, son of the infant Don Ferdinand, duke of Visco, succeeded his cousin John II. in 1495. He was then in his twenty-sixth year, and highly esteemed for the excellent qualities of his mind. He began his reign by restoring the nobility to that consequence in the state of which it had been the policy of his predecessor to deprive them. He shewed an inclination to favour the Jews, who had been enslaved in the former reign; but by the violence of his advisers, he did not dare to follow the bent of his own mind, and demanded of these unhappy people, as the terms of their liberty, that they should instantly profess themselves Christians, in name, though a period of twenty years should be allowed them for their conversion. Most of them complied with the required condition; but others, and those not a few, voluntarily put an end to their lives, rather than submit to a dereliction of principle. Some of them were so indignant at the requisition that they first murdered their own children, and then

then committed the rash deed upon themselves; thinking death in any form better than an abandonment of the religion of their fathers. In 1496 he married Donna Isabella, daughter of Ferdinand and Isabella of Spain, who died the next year, having first given him a son and heir. This was the period in which the new passage to the Indies was discovered by Vasco de Gama, a circumstance which proved the source of great riches to Portugal, and contributed to fix the epithet of *fortunate* upon this prince. In 1499 he married the younger sister of his late wife; and in 1501, under his auspices, the Brazils were discovered, which have proved a more lasting benefit to Portugal than her Indian possessions, and which has at length become an asylum to the exiling monarch, driven by Bonaparte from his European possessions. Emanuel, in gratitude for the important discoveries made in his reign, founded the famous monastery of Bethlehem, near Lisbon. He now adopted the plan of making conquests in Africa, in which he was not very successful, but by the talents of Albuquerque he formed a very useful alliance with the king of Congo. Although prosperous in a high degree, he met with mortifications sufficient to lead him to declare his purpose of resigning his crown into the hands of his son. The eagerness which the young man shewed for power, and the marked attention which the courtiers paid him, caused the monarch to change his purpose. He died in 1521, in the 53d year of his age, at a time when he was regarded as one of the most powerful and splendid princes in Europe. Emanuel, when religion was out of the question, was capable of liberal and generous conduct. He treated with great favour Don George, natural son of the late king, for whom his father had endeavoured to procure the succession to the crown; and he restored to their titles and estates the Braganza family, who had suffered attainder and confiscation in the late reign. In the history of his country, Emanuel stands very high for piety, humanity, munificence, and those other good qualities that do honour to an enlightened sovereign. Univer. Hist.

EMANUEL-PHILIBERT, duke of Savoy, son of duke Charles III., was born in 1528, and though destined for the church, yet by the early death of two elder brothers, he was brought up as heir to the sovereignty. He visited the court of the emperor Charles V., by whom he was created knight of the Golden Fleece. He accompanied Philip II. into England, and was afterwards entrusted by him with the command of his armies. He was general at the siege of Metz, and at the battle of St. Quintin, in 1557, in which the French sustained a signal defeat. He married Margaret, daughter of Francis I. of France, and by that alliance regained all the dominions which his father had lost. At the persuasion of some bigots he attempted the extirpation of the Vaudois, protestants of Savoy, but was defeated in his projects, and by the influence of the duchess, who was well disposed towards the reformation, he willingly allowed them the exercise of their religion. He died respected and beloved in 1580, after a reign of 27 years. Univer. Hist. Moreri.

EMARGINATUM FOLIUM, in *Botany*. (See LEAF.) The term applies only to the extremity or apex of a leaf, and expresses a notch in that part, apparently caused by a greater tightness or contraction in the nerve, than in the softer more dilatible parts adjacent, which are therefore extended beyond it. The petals of flowers, however, are very often emarginate in their original conformation, as in many species of Chickweed or Sandwort.

EMASCULATION, the act of taking from a male

those parts which are characteristic of his sex. See CASTRATION.

EMAUX *de P'Esu*, in *Heraldry*, the metals and colours of a shield, or scutcheon.

EMBA, or YEMBA, in *Geography*, a river of Russia, which takes its rise in the southernmost part of the Ural mountains, and constitutes the border between the Usimskoi government and the country of the Kirchitzzi, though the forts are much more to the west, namely, on the river Ural. The Emba takes up only one river of note, the Sagifs, has a strong current, but is at the same time very shallow. It is the most easterly of all the rivers that fall into the Caspian.

EMBABE', a village of Egypt, opposite to Boulac, near Cairo, upon the west bank of the Nile, famous for the excellent quality of its butter, and for a variety of lupins, which grow in its vicinity, and called embaben. These are sold ready dressed in the streets and markets, and they supply Lower Egypt. Their general appellation in the country is "termefs." The Christians of the East eat lupins as a stimulus for drinking brandy. Flour is made of them, which is used for cleaning the hands and softening the skin. The stalk, reduced to ashes, is preferred to other charcoal in the composition of gun-powder.

EMBALMING, the opening of a dead body, taking out the intestines, and filling their place with odoriferous and desiccative drugs and spices, to prevent its putrefying.

The word is formed from *balm*, which was a principal ingredient in the embalmings of the ancient Egyptians.

Dr. Grew, in his *Museum Regalis Societatis*, is of opinion, that the Egyptians boiled their bodies in a large cauldron, with a certain kind of liquid balsam. His reason is, that in the mummies preserved in the collection of the Royal Society, the balm has penetrated not only the fleshy and soft parts, but even the very bones; so that they are all as black as if they had been burnt.

The Peruvians had an effectual method of preserving the bodies of their incas, or kings, embalmed.

The mode of embalming dead bodies among the Egyptians was as follows: when a man died, his body was carried to the artificers, whose trade it was to make coffins; they took the measure of the body, and made a coffin for it, proportioned to its stature, the dead person's quality, and the price that people were willing to give. The upper part of the coffin represented the person who was to be shut up in it, whether man or woman. If it was a man of condition, this was distinguished by the figure which was represented on the cover of the coffin; there were generally added paintings and embellishments, suitable to the quality of the person. Vide Cassian Collat. 15. cap. 3. & Cicero, Tusc. Quæst. lib. i. Herodot. lib. ii. cap. 86. Diodor. lib. ii. cap. 5.

When the body was brought home again, they agreed with the embalmers at what rate particularly they would have it embalmed, for the prices were different; the highest was a talent of silver, estimated at about 25*l.* 6*s.* 8*d.* or, as others say, about 300*l.*: twenty minæ was a moderate one, and the lowest price was a very small sum. They immediately sent for a designer, who marked the body, as it lay extended, at the place where it should be opened, on the left side, and the length of the incision. A dissector, with a very sharp Ethiopian stone, made the incision, and hurried away as fast as he could, because the relations of the person deceased, who were present, took up stones, and pursued him as a wicked wretch, with an intention to stone him.

This operation being finished, the embalmers, who were looked upon as sacred persons, entered to perform their office.

## EMBALMING.

office. They drew all the brains of the dead person through his nostrils, with a hooked piece of iron, provided particularly for this purpose, and filled the skull with astringent drugs; they likewise drew all the bowels, except the heart and kidneys, through the aperture which they had made in the side. The intestines were washed in wine from the palm-tree, and in other strong and binding drugs. The whole body was anointed with oil of cedar, after having been filled with myrrh, cinnamon, and other spices, for about thirty days, so that it was preserved entire, not only without putrefaction, but had a good scent with it. *Αιγυπτίοι δε τα νεκρά εξελόντες ταμιχέουσιν αὐτούς.* And the Persians, as the same author, Sextus Empiricus, observes, were used *νεκρῶ ταμιχέουσιν.* Sext. Empir. Pyrrhon. Hypoth. lib. ii. cap. 24.

Bodies thus preserved are called *mummies*, from the Arabic word *mam*, which signifies wax, this being an ingredient in the preparation.

After this the body was put into salt for about forty days; wherefore when Moses says, that forty days were employed in embalming Jacob, we are to understand him as meaning the forty days of his continuing in the salt of nitre, without including the thirty days past in performing the other ceremonies above-mentioned, so that, in the whole, they mourned seventy days in Egypt, as Moses likewise observes.

Afterwards the body was taken out of the salt, washed, wrapt up in linen swaddling-bands, dipped in myrrh, and rubbed with a certain gum, which the Egyptians used instead of glue. Then the body was restored to the relations, who put it in a coffin, and kept it in their houses, or in tombs made particularly for this purpose. There are some found, at this day, in Egypt, in chambers, or subterraneous vaults, which fully justify the truth of what is here said.

They who were not rich enough to bear this expence, contented themselves with infusing, by a syringe, through the fundament, a certain liquor extracted from the cedar, and leaving it there, wrapt up the body in salt of nitre. This oil preyed upon the intestines, so that when they took it out, the intestines came along with it dried, and not in the least putrefied. The body being inclosed in nitre, grew dry, and nothing remained besides the skin glued upon the bones. They who were too poor to be at any considerable expence, did no more than cleanse the inside, by syringing a liquor into it; this done, they put the body, without farther ceremony, into nitre for seventy days, in order to dry it. Calmet, Diction. Bibl. Pococke's Description of the East, vol. i. p. 230, &c.

The present method of embalming in Egypt differs very much from the ancient. Mallet informs us, that it is now the custom to wash the body several times in rose-water; then to perfume it with incense, aloes, and other odours, in great abundance; the body is afterwards wrapped up in a winding-sheet, made partly of silk, and partly of cotton, moistened probably with some liquid perfume; this is again covered with another cloth of unmixed cotton, to which is added one of the richest suits of clothes of the deceased. Letter X. p. 88.

The art of embalming, says Sonnini, is now unknown to the Egyptians. As soon as a person is dead, they press the different parts of the body, in order to make it discharge all its impurities; they repeatedly wash it, shave it, pluck out all the hair, and stop all the apertures closely with cotton; they then pour upon them odoriferous waters, and the perfumes of Arabia penetrate into all their pores. The in-

animate remains are then committed to the earth; and upon the spot where the head of the deceased lies, they erect a small stone pillar, crowned with a turban. Every Friday they resort to the foot of this sepulchral monument, and renew their mournful adieus.

Dr. Ward, in his Dissertations on this subject, supposes that the Jewish method of embalming was very different from the Egyptian, and that this appears from several passages in the New Testament. Both, as he conceives, swathed up their dead; but instead of the Egyptian *embowelling*, he supposes the Jews contented themselves with an *external unctio*; and that instead of myrrh and cassia, they used myrrh and aloes. To this account he also adds the supposition, that St. John might mention the circumstance of our Lord's embalming, in order the better to obviate the false report which then prevailed among the Jews, that the body of our Lord had been stolen away in the night by his disciples; for the linen, he supposes, could not have been taken from the body and head, in the manner in which it was found in the sepulchre, on account of its clinging so fast from the viscous nature of these drugs, if they had been so foolish as to attempt it. It is certain that the modern Egyptian mode of embalming, if it may be so called, differs very much from the ancient; but it is not easy to determine how far the Jewish method, in the time of our Lord, differed from that of the Egyptians. It does not appear indeed to be certain, that the Jews were not accustomed to embowel their dead in embalming. As all other nations seem to have embalmed exactly according to the Egyptian manner, the same causes that induced them to do so, probably occasioned the Jews not to vary from them in this respect. It does not, however, follow from hence, that our Lord was embowelled, though St. John says (ch. xix. 40.), that he was buried with spices, "as the manner of the Jews was to bury;" for these words do not necessarily signify, that all was done that was wont to be done in those cases among the Jews. Indeed, the contrary appears to have been the fact, from the farther preparations made by the women, who probably were not acquainted with what had been done, though Dr. Ward supposes the contrary; since St. Luke expressly tells us (ch. xxiii. 55.), that "the women, which came with him from Galilee, followed after, and beheld the sepulchre, and how his body was laid." Admitting this statement, Ward's thought concerning the difficulty of taking off the bandages, besmeared with very glutinous drugs, must appear to be unfounded; for in that case, the women could have done nothing more as to the embalming of him. Besides, aloes and myrrh do not appear to possess that very glutinous quality which Dr. Ward ascribes to them; and it is more reasonable to suppose that St. John mentions this circumstance, concerning which the other evangelists are silent, because he published his history for the use of persons less acquainted with the customs of the East, than those for whose information the others wrote. This reason induced him to say to those who were wont to *burn* their dead, that our Lord was *buried with spices*, which was in general the Jewish method of disposing of their dead; and this he might very well do, though the shortness of the time occasioned some deviation from what they commonly practised. This shortness of time prevented them also from swathing him with that accuracy and length of bandage, which they would otherwise have used; in conformity to the custom observed among the Egyptians, and probably also among the Jews: for we are informed, that the Egyptians have used above a thousand ells of filletting about a body, besides  
what

what was wrapped about the head. Such, indeed, was the hurry of the disciples, that our Lord's head was simply bound about with a napkin; a practice used by the Mahometans at this time. What was done by Joseph and Nicodemus with the mixture of myrrh and aloes, which they provided, doth not appear. Dr. Lardner supposes, they might have formed a bed of spices. A modern Jew, cited by bishop Kidder, objects to the history of the New Testament; alleging that the quantity was sufficient for 200 dead bodies, that is, allowing half-a-pound for each body. But this quantity falls far short of that which modern surgeons use in embalming. It appears from what Josephus (Antiq. lib. 15.) says of the funeral of Aristobulus, the last of the high priests of the family of the Maccabees, that the larger the quantity of spices used in their interments, the greater honour was thought to be done to the dead; and therefore we may easily account for the quantity brought by Nicodemus, though we may not be able to tell precisely how he disposed of it. Might not large quantities of precious perfumes be strewed, or designed to be strewed, about the body of our Lord? Harmer's Obs. vol. ii.

It is no wonder that we find human bodies preserved without corrupting for many ages, by means of spices, and other ingredients, proper to resist putrefaction, applied with the nicest care; but it is strange that there should be a sort of embalming performed by nature, in some places, where bodies are preserved merely by the virtues of the soil in which they lie; yet this is evidently the case in some instances. We have, in the Philosophical Transactions, an account of a man and a woman who were lost in the great fnows on the moors of Hope, near the woodlands in Derbyshire, on the 14th of January, 1674. These persons were not found till the 3d of the May following, at which time they smelt so strong, that the coroner prudently ordered them to be buried on the spot. These bodies lay buried in the peat-moss 28 years before they were looked at again; when some people of the country, who had heard of the strange virtues of the soil thereabouts in preserving dead bodies, opened the ground, and found them no way altered, the colour of the skin being fair and natural, and the flesh as soft as that of persons newly dead. Phil. Trans. N<sup>o</sup> 434, p. 415.

After this the place was remarked where they lay, and they were shewn for a sight for 20 years, though they were much changed by having been so often uncovered in that time.

**EMBANKMENT**, in *Rural Economy*, a large body, mound, or bank of earth, constructed and thrown up in different ways, according to circumstances, with the view of guarding, protecting, and defending lands on the borders of the sea, rivers, and lakes, from being inundated and injured by them.

They are of different kinds and forms, according to the nature of the situations and the materials of which they are constituted. In embanking against the sea and large rivers, where the slopes next them are naturally gentle and easy, they are mostly of the earthy description, being well put together, and covered on the surface with turf cut from the tough sward of the land in the neighbourhood; but, in cases where the banks, borders, and shores, are more steep and bold, they are usually of a more hard and solid nature: being often made with stone, brick, gravel, sand, shells, and other similar substances, laid closely in some sort of tenacious material, such as clay, mortar, and other matters of the same quality. Wood is likewise, in some instances, employed in their construction.

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In works of this sort, very much depends upon the form in which they are constructed, and the nature and management of the materials which are made use of in the business. In respect to the first, it may be remarked, that banks of these kinds are commonly constructed with too narrow bases for the heights which are given them: from which circumstance, the sides which are opposed to the effects of the water become too steep and upright; consequently, in cases of high tides or floods, they are utterly incapable of resisting their weight, which has equally a lateral and downright pressure. Besides this, there is another disadvantage attending this method of forming them, which is, that the floods, as well as the tides, in ebbing and flowing, have a more continued action on one part than would be the case, if the slopes were more gentle and gradual; consequently, they have a much greater tendency to break down and destroy the superficial parts of the banks. With some variations in the forms, most of the embankments in this country are, however, made in this way. They may succeed in some particular instances; but in general it is found, that breaches are frequently taking place in them, from the effects of the sea or floods, which are not capable of being filled up or repaired, without considerable difficulty and trouble; and which, if suffered to continue even for a short space of time, endanger the whole embankment.

The common form of embankment is shewn at *fig. 1, Plate X. Agriculture*, and the improved form pointed out at *fig. 2*, in the same plate.

The angles or slopes of these sorts of works are made very different in different cases; but that shewn in the above figure seems in general well calculated for the purpose of resisting the impression of heavy tides, or the waters of floods. The greater breadth they have in proportion to their height, the more effectual they must be in resisting the power of the waters which come upon them.

In regulating the heights of embankments, it is necessary to ascertain the greatest depth of water at the highest tides or floods; making the summits of them about two feet higher than the points to which they rise at such times. By some, a less height than this above the highest mark of the tides or floods has, however, been considered sufficient; but it is always proper to be on the safe side, as the consequences of an overflow are very serious.

In forming embankments with stones, or other similar materials, which, as has been seen, is essential in bold steep banks or shores, it is necessary that they be laid in proper materials, and be closely jointed next the sea, or the rivers, so as to be fully capable of resisting the entrance of water; as, unless this be the case, they will by no means be complete: for the water, insinuating itself between the openings, sinks down among the stones, softens and loosens the clayey or earthy matters underneath, by which portions of them are continually forced out and washed away; hollows being formed in that way below, and the stones naturally sinking down; in consequence of which, the waters rush into the cavities with considerable impetuosity, and quickly displace others, and the whole embankment is soon destroyed. This very frequently takes place with the heads thrown across rivers, and such paved or causewayed banks as are formed with the view of protecting and preserving those bold and open shores, which are liable to be undermined and carried away by the washing operation of the waters which come against them. In order to render the embankments perfectly secure in such cases, they should be laid with good mortar, and be pointed with a strong cement. A good coat of gravel, in some cases of this kind, is even found far superior to paving with stones.

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In constructing embankments of the quay, or other similar kinds, a mortar formed from powdered unburnt lime-stone and coarse sharp sand is employed; the whole being pointed with puzzolana earth, by which they become as solid as rock, and fully resist the effects of water. The lime of particular sorts of lime-stone is found more proper for forming this sort of mortar cements than that of others: thus, that found at Dorking in Surrey is supposed to constitute the most durable substance of this kind of any in the kingdom; and has been employed in forming the new docks in the river, near London. And an excellent sort of lime-stone for the same purpose has likewise been discovered near Worsley, in Lancashire, which is there termed Sutton lime.

It has been suggested by a late writer, that an excellent mortar cement for this use, which hardens under water, may be composed by having four parts of blue clay, six of the black oxyd of manganese, and nine of carbonate of lime, submitted to a white heat, and then well incorporated with sixty parts of sand, and as much water as may be necessary to form it into a mortar.

It is invariably found, in examining the shores of the sea, and the banks of rivers, that such as have easy and gently declining slopes from their beds to their borders or banks; and those which are formed in a steep upright manner, of rocky materials, such as are shewn at *figs. 3, and 4,* are the least exposed to injury from the effects of their waters: the two former being the most secure, when spread over or coated with good coverings of sand or gravel, or uniformly turfed over quite down to the water-side with the sward of a tough old pasture. The strength and firmness of their banks are in proportion to the extent of the slope; and their durability depends on that of their being made uniform on their surfaces, both in respect to hardness and smoothness: as, in the former case, from the great length of slope, the flows and decreases of the waters act more momentarily on their different parts, and their greater weight renders their banks more firm; while, in the latter case, by the equality of their surfaces, the power of the waters is rendered the same on one part as another, and no obstacles are left for the producing of eddies, or other means of forming holes or breaks in them.

In the latter, or those of the bold, upright, rocky kind of banks, their strength chiefly depends on the resistance of the large quantity of materials by which they are backed, and not on the manner in which they are disposed, as in the former case; and their durability, on that of the uniform compactness of texture in the parts opposed to the effects of the waters: as, where these have fissures in them, or are softer in some parts than others, the waters are liable to enter and break down the banks in time, according to the particular nature of the cases. A striking example of this kind lately occurred in the Isle of Wight.

It is, therefore, of importance that the modes and forms of embankment, which are thus naturally presented, should be improved upon by art. It is evident, that if a cut was formed behind the embankment, as in *fig. 5,* at the letter *x,* the shores or banks, though, in this case, as it were, detached from the land, would be found equally strong and capable of resisting the pressure of the waters, as in their original state. Hence, if a mound or bank was formed, and placed out at the distance of one, two, or three miles from the shore or other embankment, within the bed of the sea or other waters, as at *y* in the same figure, it would be equally capable of resisting them as in the former instance, and not more liable to be broken down by their pressure than in its former station; and would also defend

them as completely from the intermediate space of land, as it did before from the narrow trench. Consequently, on this principle, vast tracts of land may, in different parts of the kingdom, be obtained by judicious embankments.

Though the shores of bold steep coasts may not afford examples equally capable of being followed with advantage as the above, they nevertheless suggest useful hints for the purpose of defence, in cases of bold, abrupt, broken shores, constituted of earth, or of that material and rocky substances intermixed. It readily presents itself to the mind, that the raising a good perpendicular stone-wall against such banks, renders them nearly as strong and lasting as those formed by nature of steep, solid, rocky bodies. This sort of walled bank is exhibited at *fig. 6.* But though this method may be practised, in cases of the above kind, with great advantage, it is not by any means applicable in general to rivers; as, with them, the water, during the periods of floods, stands in need of room to spread, which is the great use of giving their banks a sloping form; while, in this way, by being confined, it would have the effect of doing more injury than was the case before. Instances may, however, happen in which it may be had recourse to with propriety, in defending a part of the bank of a river, without giving it a sloping direction, or for protecting one part of a bank at the risk of that which is opposite to it; but well-constructed piers, in such cases, are frequently more perfect, and constantly attended with less expence. But instead of these, art may suggest one that may answer in some respects more perfectly; as in place of bringing together such a mass of earthy or other substances, as may be proper for constructing such banks as are shewn at *figs. 1,* and *7,* it may be more advantageous to have one formed, such as is shewn at *fig. 8,* the side of which next the water forms with the base an angle of about 45 degrees. This will be capable of bearing all the weight or pressure of water that can possibly be brought upon it, equally well with that of *fig. 1,* except that the operation of the tides would break the superficial part of the side next the sea, unless prevented by coating it with some durable substance, such as paving stones, bricks, or other similar materials.

But various different ones may be invented between this and the first natural kind, which differ only in the degree of inclination which they have towards the sea; that which slopes in the highest degree, as *fig. 1,* having the surface covered over with sand or gravel; and that which has the least slope, as *fig. 8,* may be covered with pavement; the different intermediate slopes being protected by materials which have a quality between the two, such as coarse gravel, chalk-stones, brick, and sand, as shewn in *fig. 9.* This embankment is wholly constructed of a sandy loam, being deposited upon a soil of the same quality; but as it would not, for some time after being formed, be sufficiently impervious to water, a column of clay is carried upright in the middle, from the clayey substratum of the soil underneath, as shewn at *xx* in the section.

In cases where the shores are of a very sandy nature, it is frequently necessary to form the embankments wholly of a sort of wicker-work. In such circumstances, three or four rows of paling may be put down, of different heights; and the vacant spaces between them be well filled, by forcing in furze, brush-wood, or even straw, as represented at *fig. 10.* These substances, by detaining the mud and sand, as the tide passes through them, or during high floods, soon form a sort of embankment, such as that shewn in the above representation. It should afterwards be covered with some plant, which is capable of binding and giving it solidity, such as the *elymus arenarius.* This embankment would

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continue, during extraordinary tides, to retain still larger quantities of the sandy materials, until ultimately raised higher than they could reach, by which a safe bank would be formed. It is suggested by Mr. Loudon, in his useful "Treatise on forming Country Residences," from which many of the above hints have been drawn, that from twenty to thirty thousand acres of land might be gained in this way, in a very few years, in different parts of the rivers Severn, Humber, Frith, &c.

In all cases of embankment, however they may be formed, tunnels and sluices of a proper kind, with valves towards the sea or rivers, must be occasionally placed, according to circumstances, so as to permit the water that may be collected within to pass away, and that of the sea or rivers to flow up, with different intentions in the view of improving the land.

The utility of projecting points is very considerable, in different cases, on the sea-coasts and rivers, in defending the bays and inlets of the former, as well as guarding the banks of the latter, by diverting their streams or currents to the opposite sides. Hence arises the formation of piers, which become highly beneficial in defending embankments, as well as the borders of rivers and brooks. In the first of these cases, they may generally be constituted and coated over with the same sort of material as that of which the embankment is formed; while, in the latter, they should be formed of some sort of stony matter, being constructed in such a way as to decrease in every direction as they advance outwards, as represented in *fig. 11*. In each of these cases, they are, however, capable of being constituted of brush-wood, secured by means of stakes, often with more perfect success. And it frequently happens that a simple rude wicker-work fence, of not more than three or four yards in length, may be fully sufficient for the purpose. Embankments formed of stone, unless constructed in the manner represented at the above figure, are apt to cause eddies below them; while those formed of brush-wood cannot have this effect.

It is obvious that considerable attention must be required in deciding the most proper situations for constructing these sorts of projections in, and the distances to which they should extend into the rivers: as a too extended projection may be highly dangerous to the opposite bank, and of course do harm instead of being beneficial; while not carrying them out sufficiently may prevent the effect which is wanted. In cases where piers are to be formed of stone, as in rivers where the bottoms are of a rocky nature, the plan represented at *fig. 11* is probably the most proper, as it will scarcely cause any eddy, and be nearly equally mild with that of wicker-work in the effect which it produces. Different works of these several kinds have been constructed in the northern parts of the island with much success.

*Proper Materials for Embankments.*—There cannot be any doubt, but that different sorts of materials may be made use of in different situations and kinds of works of this nature, with more advantage than others, both in so far as duration and expence are concerned.

Those steep upright embankments which are constructed with the view of protecting bold shores, or coasts, and the banks of particular rivers, may probably be best formed of good brick, rubble, or ashler work in the manner of a wall, as seen at *fig. 6* in the plate, the materials being laid in the strongest sort of mortar that can be made. But where this is not the case, they may be built in the common way, and pointed with puzzolana earth, or what is termed the Roman cement, prepared by Messrs. Parker and Co. London.

The different kinds of sloped embankments may be formed

either with common earthy materials, clay, mud, or a mixture of these several different substances; and any other matters which are capable of uniting into a solid, firm, compact mass, may be had recourse to for the same purpose. Where the sides next the sea or other waters form angles of from twenty to thirty or even thirty-five degrees, with their bases, they may be coated with sand, the shells from the sea, or coarse gravel from the borders of the shores. And stones, broken down to uniform sizes of a few pounds in weight, may be employed in a similar manner. But where none of these substances are capable of being procured in sufficient abundance, a method practised in Holland, of covering them with such perishable materials as mats, reeds, straw, bark, and others of the same nature, may be had recourse to; but these are obviously disadvantageous, as requiring very frequent renewal. They might likewise be protected by a low fence of brush-wood, fixed in an erect manner all along at the bottom of the bank, of an equal height, as tending to break off the violence of the waves. Another method might also be employed, which is, that of covering the whole front of the bank with brush-wood, either made into bundles or in the manner of wicker-work, or fixed down in a neat manner by means of long poles and strong hooked stakes. And further, they may be laid in the form of caufeway with stones in moss, or covered with wicker-work applied upon the mossy material when spread out over the bank. And there are still many other modes which may be adopted under particular circumstances.

In all cases where the sides and slopes towards the sea constitute angles of from thirty-five to forty-five degrees, with their bases, as in *fig. 8*, recourse may be had to stones of the flag kind as coverings, which should be jointed with cement mortars formed in some of the manners mentioned above. And where these sorts of stones cannot be provided, if clay can be found, proper kinds of bricks may be made, and used in the same way as the stones. But where the slopes or inclined planes are from forty to forty-five degrees, it is frequently more cheap and economical to have them covered with stones of about six or eight pounds in weight, applied to the thickness of a foot and a half or nearly two feet; or these may be used on a bed of common moss of three inches, or of peat-moss of the flow kind, of six inches in thickness, spread upon the banks, only to the thickness of six or eight inches. Stones of these kinds may likewise be formed into a sort of caufeway, or be laid in strong clay, and their surfaces be jointed with lime or a strong cement mortar, which has the property of quickly hardening, and of enduring the operation of the air and tides, which alternately act upon it.

There may likewise be cases in which it may be the most advantageous practice to have the sides next the sea or rivers protected by coverings of wood only, in which cases, larch may be the most proper, or such others as are durable, having their surfaces covered over with pitch and some sort of sharp sand. And old sail cloth, or oil cloth pitched and coated over with sand in the same manner; or even thin plates of metals have been suggested as useful in particular instances.

*Expence of forming Embankments.*—This must obviously be very different in different situations and circumstances, according to materials and the price of labour, but though in general pretty considerable, it is seldom so high as is commonly supposed. It is probable that in cheap districts, and where the materials are plentiful, the expence of forming an earth bank covered with sand or gravel, such as that shewn at *fig. 1*, could not be less than from four-pence or six-pence, to ten-pence or a shilling the cubic yard. And such as have more steep and bold slopes, as from thirty-five to forty-de-

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grees, and are formed with pavement on the surfaces, cannot cost less than from nine-pence to one shilling and six-pence the cubic yard. One made on the plan of that shewn at *fig. 6.* could not be constructed for less than from twelve or fifteen to thirty pounds for every thirty-two yards. And one constituted of brush-wood, in the same method, for soft ground which will not admit of a wall, would not be lower than from six-pence or eight-pence to six or seven shillings for each foot forward in a lineal manner. In many situations the expences would, however, in all sorts of embankments, stand a great deal higher than these.

In some districts embankments are formed by the rod and the floor, the former being from four to five pounds, and the latter about four shillings and six-pence, the workmen finding all sorts of necessary things for the business.

*Extent of Land capable of being gained by Embankments.*—It is evident, that great quantities of land might in many situations be obtained from the sea and large rivers by the forming of proper embankments. Some notion of this may indeed be formed by a careful examination of such lands, as lie along their shores and banks, by ascertaining the distances to which the waters ebb out at common tides, as it is found by experience, that one half of the extent of land, thus uncovered in any particular situation, may at least be gained; hence throughout the whole kingdom it could hardly be estimated at a less quantity than from two to three millions of acres, but it is probably much more than even the last quantity, if it were capable of being ascertained with any degree of accuracy or correctness.

*Importance of Embankments.*—When the extent and value of the lands which are capable of being gained by these means are fully considered, there can be no doubt of their being of the greatest consequence to the interests of the country. It has been well remarked by a late writer on this subject, that there are numerous places in the kingdom where vast improvements may be effected by the judicious application of these means. Vast tracts of land of the best kind may not only be gained from the sea, but likewise from the large rivers and lakes, besides the beneficial consequences which must necessarily arise from the prevention of such rivers from overflowing their banks, and injuring the level grounds in their vicinity by such inundations. In some cases, it is supposed, that by raising a bank of only three or four feet in height, at very small expence, some thousands of acres might be prevented from being overflowed, the crops from being carried away, and much other mischief from being produced. In other instances the forming of very trifling banks might be the means of obtaining much extent of country, which in its present state is of but very little value; yet so indifferent are people in general about improvements of this description, that though immense tracts are year after year overflowed, and the most dreadful devastations committed, they have recourse to no means of prevention; nay, even though the sea itself, says the writer, as if to rouse them from their inaction, presents to their view twice every four and twenty hours large tracts that might by proper means be made of very great value, yet these repeated invitations are disregarded, and no attempts are made to possess what might, in many cases, be so easily and so advantageously acquired. This is considered altogether as extraordinary and unaccountable, while the acquisition of distant possessions is conceived by them of such great importance, as there can be no doubt but that the addition of portions of ground at home, when brought into proper cultivation, is of far greater national advantage than double the quantities gained in other distant countries.

The acquisition of additional territory at home should,

therefore, be more attended to, and have more expence bestowed upon it than has hitherto been the case. In particular situations, indeed, a few active and enterprising persons have taken advantage of the opportunities which have been presented; as in the counties of York, Lincoln, Cambridge, and others, many hundred thousands of acres have been gained by embankments. In Norfolk, too, a considerable extent of land has been gained in this way. In the neighbourhood of Chester, the river Dee company have likewise gained several thousands of acres from the sea, which have been since divided into different beautiful farms, the whole of which pay in rent more than two thousand pounds per annum. And in Holland the whole country has, in a great degree, been obtained by these means.

It is stated by Mr. Beatson, in the second volume of Communications to the Board of Agriculture, that large sums have been expended in some places by individuals, with a view of guarding against inundations; but owing to the embankments they have made being injudiciously placed, and as badly constructed, the desired effect has not always been produced, particularly in the northern parts of Cheshire, on the banks of the river Mersey, where works of this kind have been thrown up at a great expence, which, from the manner of their being placed, may, in some cases, by confining the course of the river, do more harm than good. By the appearance of that part of the country, so far as he could judge from the cursory view he had of it, it seemed to him that the inundations from that river might have been effectually prevented at a much easier rate, if a proper method had been taken at first; but from a certain ill-judged and mistaken tenaciousness of property, the embankments are reared so close upon the sides of the river, that, in many places, it is confined to a space not more than twenty yards over. Owing to this, and to an aqueduct across the river, with only one arch instead of two, which it ought at least to have had, the water sometimes, in great floods, rises, he was informed, to the height of about twenty feet above its ordinary level, and overflows the embankments, although now, by frequent additions, they are about that height. Instead of twenty yards, had these embankments been eighty or a hundred yards distant from each other, and the river widened in the narrowest places, one-third or one-fourth of their present height would have been quite sufficient. They would have been much easier constructed, and less liable to damage by the floods, and a great deal of money would have been saved, not only in the first construction, but in keeping the banks afterwards in repair. Neither would that space of ground between the embankments and the river be altogether useless; on the contrary, it would have produced the richest pasture, or meadow-hay, by its frequent manurings with the fertilizing particles left upon it, when flooded by the swelling of the river; and in those places, if any, that are unfit for pasture or hay, willows or other aquatics might have been planted to great advantage; and thus it might have been of more value perhaps than at present, and the interior grounds more effectually secured from the ravages occasioned by a sudden flood. Notwithstanding the general indolence shewn in most parts of the country respecting the acquisition of land by embanking, and the seeming aversion that most people have to engage in such undertakings, there have been, however, some ingenious and enterprising projectors, whose ideas upon that subject have soared far beyond the bounds allotted to common understandings. From the speculations of such people, the most important advantages are sometimes produced; and surely the man who is possessed of a speculative turn of mind, and who considers no obstacles insurmountable, is a much

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more useful member of society than he who is perpetually starting difficulties against every new project, and is for all things remaining *in statu quo*, that is, for leaving the world as he found it. The idea of embanking Lancaster sands, for example, never would have occurred to a torpid genius of this kind. A thousand difficulties and impossibilities would have immediately started up at such a proposal, which, to a more expanded mind, appear perfectly practicable to overcome. What then, says he, must those anti-projectors think, when they are told it is proposed to exclude the sea entirely from these extensive sands, which form a bay, exposed to a south-westerly wind, more than ten miles across, containing a surface of near forty thousand acres, and where the tide rises about fourteen to eighteen feet perpendicular height. Some proposals and estimates have already been made for carrying this project into execution. One very public-spirited and enterprising gentleman; the late Mr. John Wilkinson, offered to begin a subscription for that purpose, by leading off with the princely sum of 50,000*l.*; but so many unexpected obstacles have come in the way, by the claims of lords of the manors, and in proportioning the tithes, in the event of acquiring so large a tract of country, that few people have on that account chose to embark their fortunes in this immense undertaking, seeing that their profits may be liable to so many deductions; consequently nothing conclusive has yet been done in it. Ulverstone and Duddon sands, on the same coast, have also been proposed to be embanked. The latter, over which the writer went with major Gilpin, a gentleman who has paid great attention to that business, appears to be the most practicable. According to his opinion, there might be about nine hundred acres of very good land gained there, by laying out a sum not much exceeding 20,000*l.* If, on a correct survey being made by persons properly skilled in such undertakings, so valuable an acquisition is proved to be attainable at so small an expence, can there be the least hesitation about immediately commencing a project so highly advantageous to that part of the country, and to every individual concerned in it.

That there are many large tracts of land in different parts of the kingdom, both on the sea-coasts and on the sides of lakes and rivers, much more easily attainable than Lancaster sands, or any of the sands here noticed, there cannot be the smallest doubt. It is, therefore, an object worthy of the attention of those who are so fortunate as to possess property in such situations, to have it ascertained by persons of experience in such matters, how far the acquisition of additional portions of land may be adequate to the expence which it may be necessary to incur in procuring it.

But embankments are important in other views than those of gaining ground by them. When rivers are concerned, one material advantage is the deepening of their courses, by which vessels of greater burthen than they admitted formerly may be permitted to trade in them.

And further, as embankments become more frequent on the borders of rivers and sea shores, the intervening distances may become a sort of bays, in which accumulations of shells, mud, sand, gravel, and other matters, may take place by the influx of the tides; and these, however difficult they may be at first to epibank, will in time be as easy to perform the work on, as the natural bays and creeks are at this period. In this way many rivers, which in their present state are eight or ten miles in width at their junction or influx with the sea, may in the course of years be reduced to less than half these distances. Consequently such embankments would be equally beneficial to the proprietors of land, and the merchant or manufacturer, as many rivers would

become more easily navigable, and those obstacles which interrupt their mouths be wholly removed.

*Embanking against the Sea.*—When encroachments of this nature are to be guarded against by embankments, the methods of ascertaining their proper heights have been shewn above. But as new works of this sort, especially where the banks are large, are liable to subside too much, it may be a proper precaution to take the levels frequently for some time after they are completed, in order to guard against any mischief which might arise in this way. Where the banks are low this is not, however, so necessary, as the settling is always more or less according to their height; in low banks it will of course be very little. In the making of such embankments, it is scarcely possible to lay down any general rule in regard to their size or dimensions, as these must be directed by situation and circumstances, under the management of an expert engineer. In cases where the embankment to be formed is to exclude the sea from a piece of low marshy ground, over which it only flows at spring tides, the work is easy and capable of being accomplished at no great expence. But where it is intended to reclaim a portion of land which is covered every tide, in some bay or creek, or on the sides or windings of some large river in which the tide ebbs and flows, the business will be in some degree more difficult, according to the depth and rapidity of the current of the water. And where it is proposed to exclude the sea from some exposed situation at the mouth of a river, or in a bay or inlet, which is uncovered every tide, the operation will be the most difficult and expensive of all, according as it is exposed to prevalent winds, and the depth of the water to be resisted. Each of these situations, therefore, requires a different method of management. The business of embanking against the sea, when at any considerable distance within high-water mark, is not only the most tedious, but at the same time the most difficult of any; as when the materials are not very good and the work not well performed, the force of the water at every flowing of the tide will quickly undo all that has been effected, especially if the soil be of a sandy nature, as is often the case in such situations. If it be a strong clay, as is sometimes the case in marshy places, there will be the less risk of its being washed away. In sandy situations it has been advised by some to lay bundles of straw or reeds well fastened down, or any other impediment, to hinder the soil from being carried away by the ebbing tide. Where a sufficient supply of good strong turf cannot be had, expedients may be tried: but where such turf can be provided, as is the case in most marshy situations, and where the embankment required is not to exceed the height of four or five feet, it is best to finish the slope with good turf as expeditiously as possible, as the work proceeds; that is, supposing the length of thirty, forty, or fifty feet or yards of it can be completed in a tide; it is better to finish that length to its intended height, than to trace out or begin a greater extent than can be finished before the tide returns, by which a great deal of the soil might be carried away, and much of the work be demolished, which is not so likely to be the case when the slope is finished. Turf which contains the roots of bent or rushes is very good for this use. The first thing, however, to be done in an embankment of this kind, is to strike out the intended line of it, setting out the breadth at the base, also the width of the excavation or trench to be made in the inside, from which most of the materials that compose the bank are to be taken: this trench also serves as a drain to keep the grounds within dry. There should also be trunks or sluices at different parts of it, to shut of themselves against any external water, and to open when the tide ebbs,

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ebbs, to let out any water from within. The width of it should be proportioned to the quantity of materials required from it for the raising of the embankment, as eight, ten, or fifteen feet wide, and three or four feet deep, leaving a *berme*, or space, between the edge of the trench and the inner bottom of the embankment. If the soil be strong, one foot or eighteen inches will be sufficient for this purpose; but if loose or sandy, three or four feet at least will be required. The more easy and gradual the external slope is made, and the less sudden the resistance against the sea will be, as has been seen above, and of course the embankment be less liable to injury; this slope should therefore be formed according to the exposure of it to the winds and tides; nothing, however, can be a greater error than the making it too bold or upright. *Fig. 1.* in the plate, is supposed to be a section of an embankment of this nature, in which the base or horizontal line *g b* should at least be three times the perpendicular height *b i*, but *l m*, the inside slope, need not be more than three-fourths of the perpendicular height, that is, nine inches for every foot of rise. The inside slope should be faced with turf likewise, laid greenside downwards, as in building common sod walls. Some expert foddens can finish this sort of work extremely neat by setting the sod on edge, according to the slope intended to be given, and with proper mallets and beetles ramming the earth hard behind, which consolidates the work as it advances, and tends to render it durable. As soon as the first or lower course is finished, the upper edge of the fods is pared with a sharp knife quite even, by laying a rule to them, and then they go on with the second course, which they finish in the same manner, and thus proceed until the whole height is completed, which, when properly finished, has a smooth beautiful appearance, not a joint between the turfs being seen. Where turf is used in covering the outside slope, it should all be laid with the grass uppermost, as already noticed, and be well beaten down with a flat sod-beetle for the purpose, and in order the better to secure them, it may be proper to drive small stakes, about eighteen inches in length, through every sod. In cutting fods for this use, they should be taken up in a careful manner, and be all traced by a line of the same breadth; their edges being cut as even as possible, that they may make the closer joints, which will tend very much to their security, until they are grown properly together. In laying the different courses of such fods, care should also be taken that the joints of the one be covered by the other, in the manner that good brick work is made.

Where it is proposed to reclaim a piece of land, upon which the sea ebbs and flows every tide, to a greater depth than in the foregoing case, as in a creek, or on the side of a large river, a different mode of proceeding must be pursued, according to the soil, and the nature of the materials to be employed. Where plenty of stones can be readily procured, a bank may be formed of them, with a mixture of clay, either by means of land carriage, or which, in some instances, is better, by conveying them in flat bottomed boats, or punts, and throwing them over-board until the bank is formed. Where stones cannot be easily had, clay, or other materials proper for the business, may be thrown in, in sufficient quantity, in the same manner, with perhaps nearly equal success. It is supposed that most of the embankments in Holland were formed in this way, the clay dug from the canals being made use of for the purpose. In either case it is requisite to fix up strong poles before the work is begun, as guides for laying down the materials. Proper sluices must likewise be laid in suitable directions for taking off the back water when the tide ebbs, under the inspection of the engineer. Much, in all cases of this sort,

depends on a skilful engineer, who is capable of suggesting and contriving various means of facilitating the business, and of obviating the difficulties that may arise in its execution. A person of real genius is often capable, by his different contrivances, of rendering the accomplishment of a great undertaking comparatively easy, which to others would be almost impracticable, or carried on at such a heavy expence as to counterbalance the advantages to be drawn from it. In cases of the kind just noticed, he might suggest the erection of stages or platforms, in such a manner as to carry on the work at all times of the tide, which would be an immense saving, as the delays caused by the tides in this sort of business are both tedious and expensive. Waggon might likewise be contrived in such a way as to carry on such platforms large quantities of materials at once, which could be easily emptied and filled; and at the same time be drawn by machinery, in such a manner as to save much labour and expence, both in carriage and tide-work.

There is another species of sea-embankment which is, perhaps, the most important of any; as there are few estuaries or mouths of rivers in which large tracts of land may not be gained by it. The shoals, or flats formed at the entrance of such rivers, are mostly composed of the richest materials and most fertilising particles, brought down from the towns and circumjacent country through which they pass. Such shoals and flats may, therefore, under proper management, be in most cases readily converted into the most fertile plains. In such situations the first object is that of collecting the whole river into one stream, and preventing its overspreading a wider extent than is merely sufficient for its discharge, or it may be better, perhaps, to alter its course altogether, and cause it to be discharged at some other outlet. It is in this latter method that it has been proposed to reclaim the extensive tract covered by the tides, known by the names of the Lancaster and Milthrop sands, as well as those of Ulverston and Duddon. And the principle on which it is founded is this: it has been found by experience that where the course of a river is changed in such a manner as to make it discharge itself into the sea at a different place to that where it did before, the former place will, in a few years, by the continued accumulation of sand and mud brought in every tide, be so choaked up and raised above its former level, as to form of itself, in the course of time, a bank that, with a very little assistance, will quite exclude the sea; for as the current of the river before carried away all that sediment which the motion of the waves naturally stirred up, from its being now removed, it is obvious that all or most of the muddiness will not only be carried further up the old channel of the river, but a great part of it be deposited there as the tide recedes. It has been found that in spring-tides and particular winds, this sediment is deposited in larger quantities than at other times, and the writer has been informed that a gentleman in Lancashire, who has gained some land in this way, has found, on making a perpendicular cut in the ground so recovered, that the different layers were so distinct, he could readily distinguish those made at spring-tides from the rest. This curious fact is well deserving of the attention of all those who have lands situated at the mouths of rivers, as there may in many such situations be considerable tracts gained in this manner at a very light expence. But though this fact may exist in some places, as has been proved by experience, nevertheless it is supposed that the effect cannot be the same in all situations. Where there is a great extent of flat or muddy shores, the motion of the waves will no doubt stir up the mud or sand, and carry great quantities of them along with the current on the flowing of the tide, and when the tide ebbs, though  
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Some of the lighter particles will be carried away again, yet it is reasonable to suppose the heavier ones will be left behind. If the shores are bold and rocky, except just near the entrance of the river, there will be the less of this mud; but on such shores there can, indeed, be little or no occasion for embanking, unless perhaps in some creeks, narrow at the entrance and spreading out wide above. If the sea were excluded from such creeks, a great deal of land might probably be gained.

It was found, on having a survey made of the Lancaster sands, and of the proposed alteration of the course of the river Kent, that the length of the cut, necessary to be made from a little below Dalham Tower to the river Lune, was 21,340 yards, or twelve miles and one furlong. This cut was proposed to be about thirty-four yards wide, and four yards of average depth, making in the whole an excavation of 2,902,240 cubic yards: the expence of excavating which, at  $4\frac{1}{2}d.$  per yard, would amount to  $54,417l.$  But perhaps this estimate is rather under-rated at  $4\frac{1}{2}d.$  the cubic yard; but on the contrary the average depth of the excavation is presumed to be considerably over-rated at four yards, as a great part of the depth necessary may be made up by the soil thrown out; consequently whatever is made up cannot be considered as a part of the excavation; besides if the river Kent, Lindale pool, and the other streams proposed to be taken into this new cut, require, when united, a space or channel to contain them whose transverse section is 136 yards superficial, it would be much less expensive, it is supposed, to add eleven yards to the breadth; and to take one from the depth proposed, unless it be necessary, from the level of the bottom of the river, to make the bottom of the new cut of a certain stated depth. The whole expence of completing this great undertaking has been estimated at only 150,000*l.*, and in the opinion of some persons fifty, or perhaps sixty thousand less might be sufficient. It is, however, apprehended, that in this estimate there has been no allowance made for the necessary buildings on so extensive a tract, or for inclosing and draining; all which, as well as the interest of money laid out before any return can be expected, should be considered in calculating the expence of bringing into improvement such lands as these. And further, there are other estimates to be made for necessary buildings in its cultivation; besides in the estimates which have been made, it is taken for granted, that if the fresh water be conducted another way, as proposed, in a few years the sea will completely exclude itself from this extensive tract of land, and consequently no allowance whatever is made for any sort of embankment across those sands. Experience has not, however, so sufficiently shewn the certainty of this method of gaining land from the sea, as to place that sort of confidence in it that is requisite. If, indeed, it could be fully depended on, the speculation would be admirable, as well as the advantage and profits arising from such an acquisition immense; but if after laying out nearly perhaps 200,000*l.* in altering the course of the rivers, &c. it should be found that the sea left little or nothing behind, or if it did leave some at one time, but carried it all away at another, in what predicament must those persons concerned find themselves? They must either lose the whole of the money laid out, or they must expend at least 200,000*l.* more, perhaps, in performing what they had so implicitly trusted to the operation of the sea. If, however, it were certain that even a fiftieth part of an inch was deposited every tide, the success of the undertaking would be unquestionable, and a concern in it highly profitable, as in very little more than eight years ten feet of perpendicular height would be raised, and it would be an easy task to accomplish the rest of the business.

The Duddon sands are another tract, it is supposed, where great improvement is capable of being effected at a very easy rate, when compared with that just noticed. In the present state a great deal of land, that is capable of producing the best crops, is often overflowed and rendered so wet and marshy as to be of little or no value. While, by altering the course of that river, and bringing it farther north on the low marshy ground, it would seem from viewing it, without actually taking the levels, that not only the whole of the ground might be completely drained, but a considerable tract of lands be reclaimed. The making of the new channel for the river seems perfectly easy and practicable, the ground being nearly level, with the exception of a small rise at one place, all the way from where the new cut would begin, which is about two hundred yards above Duddon bridge to Havering pool; where it would empty itself into the sea. The length of this cut would therefore be about six miles, which ought to be made navigable all the way, with a lock near the sea, and a basin with proper landing places for delivering goods. The quantity of land that might be thus gained, including the sands and marshy ground on each side, would, it is supposed, on the authority of major Gilpin, be about 2000 acres, and the whole expence under 20,000*l.* The land, too, has every appearance of becoming one of the most fertile kind: in proof of which a farmer, who some years ago gained a few acres of it by embanking them against the sea, found that it produced the best crops of all kinds, even with little or no manure. So large a tract of valuable land, capable of being gained at so very trifling an expence, is therefore an object highly worthy of attention, not only as a profitable concern, but on account of many other advantages that would arise from it. It is, therefore, surprising, that the proprietors in the vicinity or other enterprising individuals have not long ago taken the necessary steps to reclaim these sands. The execution of these projects would, it is conceived, be attended with the most beneficial effects to a very extensive tract of country, and be ultimately felt in some measure by the nation at large. There would not merely be an addition of territory larger than either of the islands of Guernsey or Jersey, but it would tend to improve at least four times that extent of the interior country. A safe and speedy communication would be opened between the towns of Lancaster, Whitehaven, Ulverston, Ravenglass, Dalton, Bootle, Egremont, &c. and all the intermediate country, instead of a mountainous and very circuitous route, or a precarious and dangerous passage over Lancaster sands, in crossing which accidents are not unfrequent. Independently of the advantage arising from the produce of the lands to be acquired, the produce of the interior part of the country, which in many places is extremely fertile and well cultivated, would be easily brought to market; whereas it is at present, with the utmost difficulty and inconvenience, that any commodity whatever can be transported over these dangerous sands and almost inaccessible mountains. By diverting the river Duddon into the navigable cut proposed, it would yield the most important advantages to the town of Broughton and all the back country, by facilitating the importation of coal, lime, and other produce of every kind, and the exportation of slate, iron, and other productions of the country. But though different public-spirited individuals have been active in forwarding these highly laudable and important undertakings, the opposition which has been given by the proprietors of some trifling fisheries, who were offered a full indemnification, and from some lords of manors, who would neither contribute towards such improvements, nor relinquish any part of their claims to the ground when improved, they

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they have been for some time in a great measure in a dormant state. It is hoped, however, that in these enlightened times, when the spirit for improvements of this kind should be particularly aroused, these important and necessary projects may be again taken up in a serious and effectual manner, and that every obstacle which may stand in the way of their completion may be speedily removed. And that if the attempt of re-claiming Lancaster lands should be considered as a too expensive and too mighty undertaking to begin with, an experiment may be made on Duddon sands, where the money proposed to be expended is comparatively trifling, and where, if the scheme should succeed, there could not be the smallest reason for doubting the success of the other.

In the marshland district of the county of Norfolk, lying between the rivers Wyn and Ouze, immense tracts of the most rich land, such as is composed of the muddy depositions left by the tides and floods, which is there called *silt*, have been obtained by means of embanking. In this important business, the late count Bentinck, and his son, the present possessor, have been largely concerned. This kind of work has sometimes been undertaken by the tenants on a new piece of marsh, in consideration of having the land free for twenty-one years. But in these cases the banks have often been very imperfectly made, not having cost more than forty shillings a rod. And those which were constructed by the landlords were indeed frequently but little better, being mostly deficient in not having slope enough given them towards the water. Count Bentinck therefore laid his out upon a scale never practised in that part of the island before, and his successor has still far exceeded it. That planned by the former extends about four miles, and has added to the old estates not less than a thousand acres. The base of the embankment, in this case, is about fifty feet, the slope to the sea thirty-six feet, forming an angle, it is supposed, of about twenty-five or thirty degrees. The crown is four feet in width, and the slope to the fields seventeen feet, in an angle supposed of about fifty degrees; the slope towards the sea being very neatly turfed over. The first expence incurred in forming this bank was four pounds per rod, but a very high tide coming before it was finished, not only made several breaches, but occasioned an additional height and slope to be given to several different parts, in order to bring it to the dimensions mentioned above, all of which made the gross expence to amount to about five pounds the rod. The whole cost was something more than 5000*l.* The expence of the houses, farm buildings, and other things, was about as much more, for five new farms, which was a greater expence than was necessary, as the land would have let as well in two or three as five farms. Supposing, therefore, the expence at 10,000*l.* and the new rental as 1000*l.* a-year, it is just ten *per cent.* for the capital laid out. The expence here, however, seems to have run too high, when the necessary repairs of the bank are taken into the account. The representation, given at *fig. 11.* in the plate, fully explains the nature of the embankment formed in this case.

In another new embankment, in which two hundred and seventy-three acres of marsh land, and eighteen of bank were gained, the men were paid four shillings and six-pence a floor of four hundred cubical feet, finding wheeling planks, barrows, trussels, &c. When it is thus formed, the front slope is sodded, for which they are paid in addition four shillings a floor of four hundred square feet, earning from five shillings and six-pence to seven shillings a day, and there is some little further expence necessary for beating it down in a firm manner. The whole of the expence of the bank, sluice, and every thing else, was about 3300*l.* The

land was immediately offered to be rented at four pounds an acre for four years, or three pounds an acre for six years; which, in the former case, would amount to 4368*l.* in that length of time, or one thousand guineas more than the whole of the capital laid out in the undertaking.

On this coast the operation of *silt*ing up, or raising the surface of the marsh land by the repeated depositions of muddy matters from the sea, is performed in a more rapid manner than in many others; and the little hollows and creeks are found from experience to silt up much faster where the tide waters are speedily taken off by proper cuts and channels formed for the purpose, than where the contrary is the case.

*Embanking against Rivers.*—The embankments against rivers may be divided into two kinds; namely, such as are for preventing their encroaching on the adjacent lands, and for protecting those lands and the neighbouring level country from being overflowed, when the water rises above its ordinary level. It may be remarked, that where the course of a river is a straight line, or nearly so, it hardly ever makes any encroachment upon its banks, unless, perhaps, in very large rivers when they rise above their common level, either owing to an increase in the waters, or to their being, in some degree, affected by the tides. In either case, the waves occasioned by a strong wind, where the river is wide, will moulder away the banks on that side upon which it blows, unless prevented in proper time. This may be done either by securing the bank properly with stones, or by driving a row of long piles pretty close together at a little distance from the shore, the piles being of such a length, and so driven, that their tops may be always above the highest rise of the water. It is surprising the effect that piles driven in this manner have in resisting the power of the waves in such situations.

Some years ago, when Mr. Beatson was on duty as an engineer at a fort near Portsmouth, built on a point of land much exposed to the sea, the waves made such havoc, that the walls on that side were constantly giving way, although built in the most substantial manner, and having bulwarks of large heavy stone besides to protect the foundation: however, all would not do; those bulwarks were soon knocked to pieces, and several times the wall itself. At length it was proposed to drive a number of piles at about forty to fifty yards from the fort. These piles were twelve or fifteen inches in diameter, and driven about one diameter from each other nearly in a straight line, parallel to the wall where the waves did so much damage. They were driven into the ground with a pile engine till perfectly firm, perhaps eight or nine feet deep, and about two feet of the top of them left above the level of high-water mark. After this was done the wall received no farther injury, the space between the piles and the fort being always perfectly smooth, however tempestuous the waves might be without. The same simple method might, it is supposed, sometimes, perhaps, protect the banks of large rivers, if exposed to the waves, when other methods might fail.

But it is suggested, that the most common course of rivers encroaching on their banks, is the resistance occasioned by a sudden bend. In flat countries, apt sometimes to be overflowed, where there are any such bends or windings in the rivers, it would be of great advantage to straighten the course as much as possible, for, as every impediment or obstruction will naturally cause the water to rise higher than it otherwise would do, and as such bends have that effect, consequently, in the time of a flood the waters will overflow a greater extent of country, and to a greater depth than if the river had a free and uninterrupted course straight forward.

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If the windings of the river cannot be altered, and encroachments are making on some part of the banks, it must first be considered, whether the force of the water can be driven to another place where no injury can be done. If, for example, a river is encroaching on its banks, at  $x$ , *fig. 2.* a jutty of stone, a little way up the river in the direction  $yz$ , would throw off the current towards  $w$ , and might totally prevent any further encroachment. On the river Nith, in Dumfriesshire, it is stated that a good deal has been done in this way by Mr. Millar of Dalfwinton, a gentleman of the most enterprising genius and most liberal mind, who has paid more attention, and laid out more money in making important and useful experiments, than almost any other private individual. The course of the river, where Mr. Millar has been carrying on his operations, is said to be nearly as shewn at *fig. 3.* by  $rstu$ ; at  $t$ , it was encroaching most rapidly, and seemed inclined to take a new course towards  $v$ , which would have destroyed some very fine land, and done a great deal of mischief in that part of the country. To prevent this, Mr. Millar made a large cut about 400 yards in length from  $w$  to  $r$ , and threw in a great quantity of stones quite across the river at  $t$ , to direct its course in a straight line from  $r$  to  $w$ . This had, in a great measure, the desired effect, by totally preventing its progress at  $t$ , but now it began to encroach on its banks at  $u$ . He at first endeavoured to prevent this by driving in at a considerable expence a number of piles at a little distance from the bank, and wattled them with willow branches, &c. thinking thereby to protect the bank. The piles were drove in with heavy mallets, apparently firm into the ground; they continued so for some months, till a heavy fall of rain came on, which swelled the river, undermined the piles, and carried them all away. But, indeed, it is in vain to think of piles doing any good in such a situation, unless firmly driven in by a pile engine; for it is not possible to drive them in properly with mallets; this must have been the cause of their giving way so soon. The piles not succeeding, Mr. Millar was resolved to try another plan; several of his adjacent fields being covered with an immense quantity of stones, he ordered them to be gathered and thrown into the river, so as to form a jutty at  $x$ , a little way above the injured bank. Being obliged to go from home about that time, and to leave the execution of the work to some country people, they carried out this jutty too much at right angles to the stream. It had not, therefore, the desired effect, but rather made the matter worse than before; for, if a jutty is carried out at right angles, as at  $a$  in *fig. 4.* the current will be forced from  $a$  to the opposite side of the river at  $b$ , and from thence it will rebound towards  $c$ , more violently than it did before. But if a jutty be placed obliquely, as at  $d$ , it will force the current gradually towards  $e$ , in which position one jutty may do more good than several placed improperly at right angles. Mr. Millar was, therefore, under the necessity of making other jutties in this way, and has now the satisfaction to find that they answered the purpose intended. These he made laterally formed a sort of convex slope, the convexity being parallel to the current. Strong planks were also firmly set on edge among the stones, their ends pointing towards the river, so that if ever any current came so rapidly as to move any of the stones, it must move them all in a body the whole length of the plank. Perhaps this precaution was unnecessary; for although stones are thrown into a river loose in this manner, the slush sand, &c. that come down the river will soon fill up all the cavities, and render it as firm and solid as a regular built wall. Mr. Beatson has been the more particular in this description, he

says, in order to shew the errors that Mr. Millar at first fell into, and the great expence they occasioned, whereas, had he been on the spot himself, and got the work executed as he intended, it would have saved a great deal of unnecessary labour as well as money.

It is stated by the same writer, that the next sort of embankments against rivers, are those to prevent them overflowing their banks, and inundating large tracts of country. This may be considered as the simplest and easiest of all sorts of embanking, if judiciously executed. It is, therefore, the more inexcusable to see, in some places, extensive tracts of the richest meadows completely overflowed by every flood for want of them.

Two ordinary sized rivers rise no more even in the greatest flood than five or six feet above their common level, unless when they meet with some considerable interruption or confinement in their course. But if interrupted or confined, they will rise twenty feet or more, as is the case with some parts of the river Mersey already mentioned. If, for example, a given quantity of water is six feet deep, when running over a space twenty feet wide, it is clear, if that space was only made ten feet wide, the water would rise to twelve feet, and if it were made forty feet wide, the same quantity of water would only rise to the height of three feet.

It is, therefore, of great consequence, in preventing inundations, to give the river as much width as possible, by widening every narrow place. All kinds of obstructions should also be removed, whether occasioned by windings, shoals, stones, trees, bushes, or any thing else. In some cases this may even preclude the necessity of embanking; but where embanking is necessary, let the banks by all means be at a sufficient distance from each other, to contain with ease, between them, the largest contents of the river in great floods. The distance and height of the banks may easily be ascertained by measuring a section of the river when at its highest, or when the flood mark is visible. By not attending to this, a great deal of money has been thrown away on the embankments on the river Mersey, and after all they do not effectually answer the intended purpose; a great part of the country being still overflowed every time the river rises to any considerable height.

Where a sufficient distance is allowed between the embankments their height need not exceed from four to six feet. If irremovable obstacles are in the way, which cause the river to rise higher, the banks must be higher in proportion. In either case, however, the slope of these kinds of banks on each side may be equal to its perpendicular height, and the breadth on the top about one-third of that height, which, supposing the bank six feet high, the base would be fourteen feet, and the breadth of the top two feet, as shewn at *fig. 5.* in the plate.

The materials for making these banks should be taken as much as possible from the sides of the river, which will have the double effect of widening the river and forming the embankments; and there should be a trench on the inside (from which materials may also be got) with some sluices, as formerly directed, to drain off any water from within; also sluices to let in water from the river, if required, which would very much fertilize the meadows if properly laid out for that purpose.

Such farms as are situated on the borders of rivers are frequently, it was observed by a late writer, liable to much injury and inconvenience from them; 1st. From part of the soil being carried away in times of flood. 2d. From their overflowing their banks. 3d. From their flowing back in times of flood into the channels of the rivulets and streams that conduct the water from the more elevated and distant

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grounds to the rivers, whereby these rivulets and streams are made also to overflow their banks.

In respect to the first, the danger of the soil being carried away in time of floods, it is increased or decreased according to circumstances, as the form of the banks, the nature of the soil, the rapidity of the river, and the quantity of water that lodges on the margins of the banks, or falls over them into the river. Where the banks of a river are perpendicular, especially if the soil be of a rich mouldering nature, the danger of part of them being carried away by floods is much greater than where they slope gently from the surface of the field to the bed of the river, as has been already fully seen.

Where that is not the case naturally, they ought to be moulded into that form by art; as when a river, in place of being confined in its progress, has a power of efflux and reflux, the damage to be apprehended is inconsiderable, compared with what is likely to happen when, being restrained within too narrow limits, it is constantly struggling for an extension of space. Where the soil is rich free mould, and the under stratum opposite to the greatest force of the water, sand, or gravel, this struggle never fails to be attended with bad consequences. If the soil and subsoil be one entire mass of clay or strong loam, and the current of the river does not press more upon one part than another, a most substantial improvement may be effected by sloping the bank, so that the declivity may be one foot in three or four from the surface of the field to the bed of the river. This some may object to, as sacrificing a certain portion of valuable land; but it should rather, it is thought, be considered as a premium paid for the insurance of the remainder, than as a total loss. If gravel, mixed with small stones, can be conveniently procured, spreading these materials on the sloping bank to the depth of eight or ten inches, and till beyond the flowings of the river, will prove a good security against further damage; and if the bank be planted thick with any sort of willow, especially the Dutch willow, it will in a short time become an impenetrable fence, while the annual cuttings of wood will soon be equal to the heritable value of the land thus apparently sacrificed. Where no gravel can be procured, the new sloped bank should be immediately covered with well swarded turf, which should be pressed down as hard as possible, either with the back of a spade, or with wooden mallets. If this be done in the beginning of summer, and willows be planted the following autumn, the improvement, it is supposed, will be both effectual and permanent. In case the river run with extraordinary violence against any one particular part of the bank, it may be necessary to make a fence or bulwark of stone in the front of that place; the best way of doing which, is, in place of building a wall, to drop the stones in a careless manner, but so as they may lie close together on the sloped bank, as already suggested.

This is a much more secure mode of fencing, if the bank be made with sufficient declivity, than any stone wall that ever was built for the purpose, and while it is the most secure, it is also the least expensive; but care should be taken to lay the stones all the way from the bed of the river, till considerably beyond where the river flows in common. Where the soil is of a strong adhesive nature, and the under stratum is sand or a pebbly gravel, it becomes in a much greater degree necessary to slope the banks. The water, when rushing violently along, has a powerful effect in undermining the bank, and carrying off those incoherent substances; so that the soil, having nothing to support it, naturally gives way, and frequently in such quantities as to occasion very serious losses both to proprietors and tenants. In all such

cases, the slope should be made much more gradual than where the soil and subsoil is of the same quality, and such as will nourish aquatic plants. The banks, having been sloped according as circumstances require, a thick coat of gravel, mixed with small stones, where such can be procured, should be laid on so as to form a kind of natural beach, over which the river, when in flood, may have power to extend itself at pleasure. Should it be difficult or impossible to procure such materials as are proper for forming this best of all defences, strong thick sods should be placed on the surface in the manner before directed, which, if laid on in spring, or early in summer, will have time to unite, and to become one compact body before the autumnal floods (which are those whence the greatest dangers to be expected) begin to flow. If the subsoil be of such a nature as that willows will not grow, such sods as are full of the roots of rushes should be made choice of in preference to all others; as where these plants thrive and spread over the surface, it becomes in a great degree impenetrable by water, even in great floods, and when the river runs with considerable violence and rapidity.

The directions above given will, it is supposed, be found more or less practicable and useful according as the river on ordinary occasions runs with greater or less rapidity. In level, or nearly level districts, all that is necessary is to secure full scope for the rivers to overflow their usual bounds without interruption; when that is secured by either of the methods before mentioned, floods, unless very violent, seldom do any material damage to the banks of rivers in such situations. It becomes in many cases extremely difficult to fence rapid running rivers in such a manner as to prevent part of the banks from being carried away by inundation. Sloping the banks would be attended with no good consequences. Even strong bulwarks made of stone are often swept away by the overpowering flood. A method has, however, been suggested, of fencing the sides of a rapid running river, which has been practised with success, after several other attempts had failed; it is by means of a sort of large baskets, provincially termed creels, formed of hazle, willow, &c. into a kind of open net work, which being placed along the bottom of the banks, were filled with stones. This is a very simple, and by no means an expensive expedient; and as these baskets may be made to contain two or three tons of stone, it can only be on few occasions, and in very particular situations, that a basket, containing such a weight, can be displaced or carried away. Such a mode of fencing as this, it is imagined, would prove effectual in many parts of Scotland and Wales, where the rivers run with uncommon rapidity. Owing to inattention, or rather to not being aware of the consequences, much damage is often done to the banks of rivers in level districts, especially if the banks be perpendicular, and of a considerable height, by allowing the land floods to fall over them into the river. As the water from the furrows approaches the bank, it is frequently stopped in the furrow of the head ridge, which becomes for a time a kind of reservoir; the consequence of which is, that a considerable proportion of water sinks and filters through the earth, which being thus softened and swelled, is more easily undermined and carried off by the river. Sometimes little cuts or openings are made for the furrows across the head ridge, for the purpose of conducting the rain water into the river; here, again, the consequences are equally bad. Whoever will examine the bank of a river where this mode of management is adopted, and it is very common, will observe, that at every one of these cuts or openings a little creek is formed, in consequence of the bank having been more softened, and by that means hav-

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ing become a more easy prey to the river when in flood. To prevent these evils, it is necessary, besides sloping the banks, to devote a part of the lands adjoining to the breadth of twenty or thirty yards, for instance, either to pasturage or the growth of trees, and to form a drain at a proper distance from, and parallel to the bank, for the purpose of collecting and carrying off the water from the furrows. Were this done, and were the water from this drain conducted into the river by conduits formed a little above its ordinary level; much land, which is annually lost by neglecting this simple precaution, would be saved, and preserved in a proper state.

In the second case it is evident that injuries, although of another nature, are often sustained by farmers, from rivers overflowing their banks. Sometimes the farmer is prevented from sowing his field; at other times the crops of grain and grafs are greatly injured, by being covered for a considerable time with water; and at others again, the whole produce of the year, the hay and corn crops are swept away. To prevent evils so complicated, and so serious in their nature, is certainly the business of every man, who, from the situation of his farm, has reason to apprehend, that without using proper precautions, he may be subjected to such visitations. These damages can only happen in level tracts, where the banks of the rivers are low, and where the course is not of sufficient breadth to contain the water in time of flood. Some people, although very improperly, raise mounds of earth close to the top of the bank, and of a height exceeding that to which the river can be expected at any time to rise. These mounds, from being placed so near the river, are unable to resist the pressure of the water, and by giving way, frequently admit a current into the fields, which proves much more injurious in its course than if no mound whatever had been erected. Were a mound of earth, formed on the side of the drain, proposed to be made for carrying off the land water, and were that mound well sloped on the side towards the river, it would be the most secure and effectual guard against rivers doing injury to the adjoining lands, of any that could be adopted. By these mounds being placed at a distance from the river, the force of the stream would be much lessened, and the natural boundaries of the rivers greatly enlarged, as in proportion as the mounds are removed from the centre of the current of the river, in like proportion will they become more secure, as being less liable to violent pressure. The propriety of erecting these mounds at a proper distance must, therefore, be sufficiently evident, as when mounds are erected near the top of the bank, which can only be owing to ill-judged parsimony, they form as it were a part of the bank, and are liable to be undermined and swept away. Whereas, when they are placed at the distance of twenty, thirty, or forty yards, they serve rather as a boundary to confine the overflowing waters which glides along the bottom, than as a barrier to prevent the encroachments of an impetuous river during the time of floods.

In regard to the third case it is observed, that farmers who possess lands in low situations often sustain damage from rivers, in time of flood, by their flowing back into the channels of the rivulets and streams that conduct the water from the more distant and elevated grounds to the rivers, whereby these rivulets and streams are made also to overflow their banks.

The only precaution that can be adopted, in such a case, or at least the one which appears to have the greatest probability of answering the purpose, is to erect mounds at a distance from the banks, and of a size proportioned to the quantity of water which, from the cause now men-

tioned, may be supposed at any time to stagnate in these channels. This may be done at a very trifling expence either in money or land. If the proprietors do not choose to ornament the county and improve their own estates, by planting trees on the borders of the rivulets and streams, the farmers may so construct these mounds, as that they may become fences to their arable fields, while that portion of the farm, necessarily and properly cut off for the protection of the remainder, may be devoted to pasturage.

Several different embankments of a successful kind have been lately effected in the northern parts of the kingdom. An important work of this nature has been executed on the estate of lord Galloway, situated on the mouth of the river Cree, near Cree town, by his lordship's tenant, Mr. Thomas Hannay, who states in the third volume of the "Farmer's Magazine," that he "entered to the farm about four years ago, on a lease of twenty-one years, and his life; at which time upwards of 100 Scottish statute acres were regularly flooded by the highest spring-tides, excepting about three months in summer, when the tides were lower. They were seldom, however, covered above the deepness of one or two feet, and never above four or five. Eighty acres of the above consisted of a rich sea marsh, or *ings*, as they call them there, almost a true level, excepting where hollows were formed by the egress and regress of the tides, and the passage of fresh water from the higher grounds; and about four or five acres, which were about sixteen inches lower, being a younger marsh, and nothing but what they call ink-grass growing upon it (as he is no botanist he can give it no other name); other grasses, such as clover, rib-grass, &c. grew on the rest of the marsh, forming a very beautiful close cover in the summer. The other twenty acres were at an average about eighteen inches higher; consequently, the sea did not cover them so often. It had formerly been ploughed, but not for about twenty years past. Last time it was in corn, it was flooded immediately after being sown, which rendered the crop almost entirely useless, and deterred former tenants from ploughing it again. He began to bank this field in the autumn of the year 1798, by making a dike along the side opposite to the river, in a direct line facing the east. This dike was made, at an average, about three feet and a half high, and six feet broad at bottom, and twenty inches at top, built after the same manner with that mentioned below. "He inclosed, along with the said fields," he says, "four acres of the marsh adjoining, by making a dike five feet high, and five feet in bottom almost wholly of solid seals or sods, with a very little stuff, properly beat, in the heart of it, which makes an excellent fence, and promises to be a very durable one. This dike, together with two small drains, one on each side of it, about two feet deep, cost 3*d.* per yard. He has been more particular in mentioning this dike here, he says, as the division dikes of the whole marsh, which is now divided into four parts, are all built after the same manner, only that there is no loose stuff in the heart of some of them, but all of solid seal, jointed like brick, as may be seen at *fig. 6*, which represents an end-view, or section of it. This dike, meant as a permanent fence, answered as a temporary bank, and enabled him to plough that field in spring 1799, although the bank round the whole marsh was not finished till the winter following." He "sowed oats on this field, and, considering the badness of the season, had a very good crop; particularly so on that part which had not been ploughed formerly. On further consideration, he altered the plan of the bank round the marsh, (which extends in a circular direction facing the north,) by making it, at an average, about four feet and a half high, and allowing about two feet in

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the base for one in height, as at *fig. 7*, where *abc* represent an end-view, or section of it, every small span representing the section of a seal or sod; *ab* shews the inside of the bank, with the green side of the seal down; *bc* the base; *ac* the side next the water, with the green side of the seal out, (which adds greatly both to the strength and beauty of the bank); and *d* the heart of the dike, made up with stuff properly compressed with a rammer. The stuff was taken from a ditch in the inside of the bank, leaving a casement of a foot, which ought to have been three at least; and, where the ground is of a sandy nature, more; as the fresh water, running in the inside, was likely to undermine the bank, had he not prevented it, by cutting a new drain, and filling the old one with the stuff cast from it. The only creek worth noticing, through which the bank passed, was one about forty feet wide, and nine feet deep, in the bottom of which a wooden pipe, with a stopper, was laid through the bank. No tide offered the smallest injury to the bank till January last, when there was one of the highest ever remembered by the oldest inhabitant, which broke it at this creek. This, he thinks, was owing to the wooden pipe not being made strong enough, as the weight of the stuff and water pressed in the sides of it, and thereby admitted the water below. The tide made also three small breaches in that part of the bank, which was built after the first manner; but in the part made after the manner represented in the figure, no breach took place, though it was rather lower than the other part. There are now about fifty acres of the same kind of marsh land adjoining his; and also about 100 acres on the other side of the river, banked in, all nearly in the same manner as represented in the figure. The bank on the farm adjoining his, suffered little from the high tide; but the one on the other side of the river was made almost a complete wreck, owing to its lying quite opposite to the south-west winds, which always send up the highest tides; but this is not the case on this side, these winds blowing right over their bank. In his opinion, the bank on the other side of the river, in order to be durable, would require to be thirty feet broad, and eight feet high, covered with seals, with the green side out; and that no stuff should be lifted within six or seven feet of it, the ground being of a sandy nature. It might be made after the form shewn at *fig. 8*. He has now got the breaches in his bank made up, and has begun to give the whole a complete repair, by adding, at an average, fifteen inches to its height, and two feet of base for each foot in height. The whole bank is about 1500 yards in length, and, when the repairs are completed, will altogether cost him betwixt 80 and 90*l*.

“In the year 1800, he ploughed another field, he says, of about twenty-six acres of the marsh, besides the one formerly mentioned, on which he had an excellent crop of oats, thought by many to be the best they had ever seen. Last year, he had the same field, part in oats, and part in wheat: the wheat was a very good crop; and the oats, which were of the Polish kind, far exceeded the crop of the former year. Last summer, he levelled the old ridges of the first-mentioned field, all by the spade; gave it a complete summer-fallow; shelled and dunged it well; had part sown with wheat, part with potatoe-oats, and all with grass-seeds. The other field is sown, part with wheat, and part with beans drilled; and, what is very surprising, he says, although the wheat was covered several times by the salt water, when the bank was broke, some of it to the depth of three feet, yet it is all looking well. The whole marsh is, he says, this year, under the plough. It may be worthy of observation, that the four or five acres, which

he mentioned as being a younger marsh, harrowed easier than the rest, and produced as good, if not better, crops.”

Another improvement of the same nature has been accomplished, on what in Scotland is termed Carse land, on the farm of Netherton of Grange, belonging to James Peterkin, esq. by Mr. John Hoyes, his tenant; the estate having been let to him on a nineteen years lease. The work was undertaken under an agreement with the proprietor, to allow one year's rent of 195*l*. sterling, with the further allowance of ameliorating the farm-houses to the extent of 150*l*. more. It is stated in the work already mentioned, that, “under these circumstances, the embankment was begun about the 1st of June, 1802; and, in November, it was brought to its full height over the whole; so that the Carse has been completely defended from the sea ever since the spring tides in October. He cannot positively ascertain, he says, the extent of ground gained, as it has not been measured since the dike was erected; but, from the last survey of that part of the estate, it would appear fifty acres were improveable; from which is to be deducted the quantity occupied by the base of the dike, the border on the outside, with a few detached spots, probably included in the measure.” The method adopted for carrying on the operations was this: “After looking over the Carse, and marking out the line or dike, the length of which is 1400 yards, mostly in a right line, except an angle at the distance of 300 yards from the west end, and a segment of a circle at about 250 from the south-east end, it was resolved to make the embankment six feet of height in the highest part of the ground, and to allow two feet of breadth in the bottom of every foot of height, as seen by the draught of the mould at *fig. 9*. After taking the level of the Carse, it was found, he says, that where the ground was low, and a good deal of it broken by runs of the sea and outlets for the water, the dike would require to be eight and ten feet high, to have it on a level at the top; so that the average will be nine feet high. The embankment was built in the following manner: It was begun on the highest ground, near the west end, and two moulds set up at the distance of seventy or eighty yards; the height six feet by twelve broad in the base; the slope on the outside six feet, on the inside four feet, and the breadth at the top two feet; the sides made up with seal from the broken ground on the outside of the dike, which were laid with the grass-side down, two feet deep on each side of the dike; the outside seal of the first course with the ends out and in, and the other running along; the next course, the outside seal running along, and the inside out and in, and so on alternately, each course consisting of a head and runner; the body of the dike being made up of the Carse ground from which the seal had been cut, and packed down by men with beaters. When this was brought to the height of four or five feet, another piece was begun, leaving an intermediate space, where there were any water-runs, for the egress of the tide: this was found necessary, to draw off the water from the low parts of the Carse, which would have been filled up in spring-tides; and, by coming in at the end and over the high ground, would have been prevented from getting out by the dike, if it had not been done in that way; so that the embankment was all in detached pieces, till it was brought near the height. These intermediate spaces were then filled up, betwixt the fall of one and rise of next spring-tide, after laying down wooden pipes with stoppers in the dike, to carry off the sink-water.” He adds, that “it was a great labour to get the work carried on; in some places having to cross over lakes and runs made by the tides, which required vast quantities of materials, the dike being

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in some places upwards of ten feet high; and twenty-two broad in the base: the greatest part of the dike is sixteen to eighteen feet broad. There was one lake, of 150 feet in length, and fifty feet in breadth, filled up with earth, clay, and sand, to the height of five feet; on which the dike was then built. This forms a mound, on the outside of the dike, of fifteen or sixteen feet broad; and through this there are pipes laid, to carry off the sink-water." He further adds, that "a stream of water formerly ran this way; but it was turned by the west end of the farm, by cutting a canal, which conveys the water through the embankment there, by means of an outlet built of stone, with a sluice on the inside, raised to the level of the running water, and a folding-door on the outside, to be shut by the spring-tides. At this place, a road, that formerly led to Findhorn at low water through the Carse, is carried over the top of the dike, by making a mound of earth at each side, with a gradual approach and descent." It is stated further, that "since the Carse has been enclosed, the tides have been so high, that the water, during a severe storm, was from six to seven feet deep at the back of the dike: the wind, being from the north, occasioned a heavy swell and surge, but no water came over the top of it." He suggests, that "it is in contemplation, as soon as the ensuing season permits, to cover the outside with seals, the green side uppermost; and he has no doubt, when finished, it will effectually secure the lands from any further visitation of the sea. The expences of the embankment cannot be well ascertained at present; but it will be a good deal more than is allowed by the proprietors." He says, that "a great part of the land is already ploughed; but, the winter setting in so severe, prevented the whole from being done. It is intended to fallow it, in preparation for a crop of oats in the succeeding spring; but this intention may not be unalterably adhered to. There are various sorts of soil in it: some of it clay, sand, gravel, black rich earth, and parts of it of a mossy nature; in some places below the gravel, which may, he thinks, have been forced on by the tides, a thin stratum of clay, upon sand; and some parts, clay and sand alternately. There are other parts not so rich as might be expected, the surface having been carried off by former tenants, for mixing in their dunghills or compost heaps. In *fig. 9, a* is the breadth of the dike at the top, when finished; *b*, the breadth of dike at bottom, being twelve feet, when it is six feet high; *c*, the breadth when eight feet high; *d*, the breadth when ten feet high; *f*, the slope on the sea-side of the dike, which is always equal to the half of the breadth of the bottom: the inside slope, and breadth of the dike at top, is equal to the other half; and *e* is a plumb-rule in a frame, made to apply to the mould or dike: the intention of it was, to find if the dike was kept on the proper slope, where a line could not be applied from one mould to another, as in a round or turn, or when the moulds were obliged to be taken down; but this one only answered for the sea-side, another being used for the inside, to fit its slope." *Fig. 10.* is a scale of the mould one-eighth of an inch to a foot.

Various other improvements of this nature have been accomplished, in particular circumstances and situations; and large tracts of land thereby rendered more than doubly beneficial to their occupiers. The methods which have been had recourse to, in such cases, will be fully detailed in speaking of *Hough-land and Rivers*.

A curious, useful, and highly ingenious method of embanking, and preventing the waters of the tides from soaking through the porous banks, formed in fenny and moorish

situations, has been described by Mr. John Smith, in the fourth volume of "Communications to the Board of Agriculture," who begins by "consistently observing, that the great land of the fens is divided into three large levels; and that each of these levels is subdivided into numerous districts by banks: but as these banks are made of fen moor, and other light materials, whenever the rivers are swelled with water, or any one district is deluged either by rain, a breach of banks, or any other cause, the waters speedily pass through these light, moory, porous banks, and drown all the circumjacent districts. The fens have sometimes sustained 20,000*l.* or 30,000*l.* damage by a breach of the banks; but these accidents seldom happen in the same district twice in twenty years; the water, however, soaks through all fen-banks every year, in every district; and when the water-mills have lifted the waters up out of the fens into the rivers in a windy day, a great part of the water soaks back through the porous banks, in the night, upon the same land again." And he adds, that "this water that soaks through the bank drowns the wheat in the winter, washes the manure into the dikes, destroys the best natural and artificial grasses, and prevents the fens from being sown till too late in the season. This stagnant water lying on the surface, causes also fen agues, &c. Thus, says he, the waters that have soaked through the porous fen-banks have done the fertile fens more real injury than all the other floods that have ever come upon them."

Having been much concerned in fen-banking from his youth, he had some time since devised the plan which he now finds to answer so well; but found it difficult to prevail with any gentleman, who had a proper extent of this sort of land, to give it a fair trial. However, during the last autumn, he prevailed with a person in the parish where he lives to try it, which shewed it to be equal to his highest expectations.

This improved method of embanking chiefly consists in this: that "a gutter is cut eighteen inches wide, through the old bank down to the clay, (the fen sub-stratum being generally clay,) the gutter is made near the centre, but a little on the land-side of the centre of the old bank. This gutter is afterwards filled up in a very solid manner with tempered clay; and to make the clay resist the water, a man in boots always treads the clay as the gutter is filled up. As the fen-moor lies on clay, the whole expence of this cheap, improved, and durable mode of water-proof banking costs in the fens only sixpence *per* yard. This plan was tried last autumn on a convenient farm, and a hundred acres of wheat were sown on the land. The wheat and grass lands on this farm are now all dry, whilst the fens around are covered with water. This practice answers so well on this farm, that all the farmers in this parish are, he says, improving their banks in the same manner, and some have begun in adjacent parishes."

It is unquestionably a mode of practice that requires to be fully known and understood, in all those districts which have lands of this description; as by it great advantages may probably be derived.

*Embanking against Lakes.*—The business of forming embankments, in cases of what are termed lakes, or mires, in this part of the country, and loughs in Scotland and Ireland, is much more simple and easy than in the preceding cases. It has been remarked by Mr. Beatson, that the waters in these situations generally subside during the summer months, rising considerably in winter, and whenever the season is very wet. In particular cases, the extent of surface, which is overflowed in the winter season, so far exceeds

exceeds that which it covers during the summer, that it would be an object, and sometimes a considerable acquisition, to confine the water within its summer boundaries, or to cut off some of its parts. Where these are intended, the principal outlet must be first carefully examined, and be considerably widened and enlarged; which, on the principle already noticed, in speaking of rivers, will prevent the water from rising so high as was formerly the case. Where the levels will not admit of much depth being had, or where the ground is of a rocky nature, and would of course be difficult and expensive to deepen, the breadth should be increased as much as possible, and all obstacles cleared away, that the water may run freely in a shallow stream. Where it is required to ascertain with exactness, or to fix with certainty, the future limits of the water, a section of the greatest quantity running out during a flood should be taken. Suppose this section, for example, be ten feet in width and four feet in depth; by making it forty feet in width, the same quantity of water will not rise above one foot: consequently, by this means alone, three feet in height will be gained all round the lake, which, in case of embanking it, would be a great object. During the summer season, when the water is lowest, is the most proper time for carrying on these, as well as other embankments. When, however, any materials are to be brought from a distance, they may be laid down or be prepared at other seasons, with the exception of turf, which should always be used as soon as possible after it is cut. The manner of constructing embankments of this kind may be sufficiently understood, from what has been already said in the other descriptions of embankments: observing, however, as a general rule, that when the materials on the spot will answer the purpose, they should invariably be made use of, although at the expence of digging a trench larger and deeper than would otherwise be necessary. It should constantly be attended to, in executing all sorts of embankments, that the greatest care be taken to make them perfectly firm and solid, by continually beating them, and examining them carefully, during the whole of the time they are in the state of being formed.

The various methods and plans of management, which are necessary to be adopted in the improvement of such lands as have been gained from the sea, will hereafter be more fully considered and explained. See *MARSH-Land*.

**EMBANKMENT**, in *Canal-making*, is a term for any large mound of earth, either for confining the water of a canal or reservoir, or upon which a canal or aqueduct is formed across a valley or low piece of ground. It may have arches under it, for the passage of a road, a river, or brook: such are called *aqueduct-arches*, and ought by all means to be constructed on the true curve of equilibration, for avoiding the great expence and disgrace which attends the failure of less scientific arches, as at Wolverton on the Grand Junction Canal. See *CANAL*.

**EMBAR**, in *Geography*, a town of Africa, in the country of Senegal.

**EMBARCADERO**, in *Commerce*, a Spanish term, much used along the coasts of America, particularly those on the side of the South sea.

It signifies a place which serves some other considerable city farther within land, for a port, or place of shipping, *i. e.* of embarking and disembarking commodities.

Thus Calao is the embarcadero of Lima, the capital of Peru; and Arica the embarcadero of Potosi. There are some embarcaderos forty, fifty, and even sixty leagues off the city which they serve in that capacity.

**EMBARGO**, a restraint or prohibition, laid by a sovereign on merchant-vessels, to prevent their going out of port; sometimes to prevent their coming in; and sometimes both, for a limited time. See *PROCLAMATION*.

Embargoes are usually in time of war; in apprehensions of invasions, &c. One great occasion of embargoes is, that the government may make use of the merchant-vessels, with their equipage, &c. in armaments, expeditions, transporting of soldiers, &c.; another is, to stop the communication of intelligence at such critical seasons. Embargoes are of very mischievous consequence to commerce.

**EMBARKATION** of *Ordnance and Stores*. The first thing necessary is to prepare a list of all the articles to be embarked, with the weight of each. This list must have an ample column for remarks; and the reputed tonnage must have an allowance of one-third added, for all articles whose weights and measures are not always the same, but receive, or lose, in consequence of damp, dirt, &c.; such as tents, &c.: but the tonnage of ordnance, shells, shot, &c. should be set down at their actual weight, according to their natures, calibres, &c. respectively. If vessels are paid for according to the tonnage they carry, the master will, of course, stow away to the best advantage, and load with as much as the vessel can possibly contain; whereas when freighted for a voyage, upon the estimated tonnage of the hold, they will stow so very loosely, as both to carry less, and to subject the cargo to considerable injury. It is, therefore, proper that a naval officer should be appointed to superintend every embarkation, and to see that every thing is stowed to the best advantage. It may be useful, in this place, to shew how tonnage is estimated. The usual method of finding the tonnage of any ship is,—Multiply the length of the keel by the length of the beam, and half that product by the breadth of the beam; divide the last product by 94, and the quotient will be the ship's tonnage. Thus, say a ship's keel measures 90 feet, and that her beam, *i. e.* her extreme breadth, be 30:

$$90 \times 30 = 2700 \times 15 = \frac{40500}{94} = 430.8 \text{ Tons.}$$

The tonnage of goods and stores is taken sometimes by weight, and sometimes by measurement; and that method is allowed to the vessel which yields the most tonnage: were it otherwise, the owners would be considerably losers in the freight of bulky, light articles, on which the calculation by weight would give them but little claim to charge; and, *vice versa*, if ordnance, shot, &c. were to be carried by measurement, they would be under a similar disadvantage. In tonnage by weight, 20 cwt. make a ton; and in tonnage by measurement, 40 cubic feet make a ton, the same as in timber computations. All carriages, or other stores to be measured for tonnage, should be reduced to their smallest dimensions, by taking to pieces, and packing into as little space as possible. All ordnance is shipped according to actual weight; as are also musket cartridges in boxes or barrels, and other such ponderous articles. The following table will exhibit the rates of tonnage allowed for the embarkation of the most material stores in the ordnance department.

# EMBARKATION.

NATURE.	Number of Articles or Quality.	Tons. Cwt. Qrs.
Axes complete with Handles	Pole fort 264	0 10 0
	Pick 100	0 9 0
	Felling 176	0 14 0
Barrows, Wheel, Packed	20	2 2 0
Do. Unpacked	7	1 0 0
Do. Hand, Single	20	0 18 0
Budge (or Bouche) Barrels	32	1 0 0
Bricks	1000	2 5 0
Buckets of Leather	20	0 2 0
Carabines, 25 in a Chest is 11 Square Feet.		
Carriages, Standing	42 Pieces	1 13 0
Do. Do.	32 Pieces	1 10 0
Do. Howitzer	10 Inch	1 10 0
Do. Do.	24 Pieces	1 9 3
Do. Do.	18 Pieces	1 7 0
Do. Do.	8 Inch	
Do. Do.	12 Pieces	1 4 0
Do. Do.	9 Pieces	1 3 0
Do. Do.	6 Pieces	1 0 0
Do. Do.	4 Pieces	0 17 0
	24 Pieces	5 10 0
	12 Pieces	4 10 0
Carriages, Travelling, complete, with Limber Boxes, Ladles, Sponges, and Rammers	9 Pieces	4 7 2
	6 Pieces	3 7 2
	3 Pieces	2 19 0
	Medium { 24 Pieces }	2 9 3
	12 Pieces }	
Carriages, 6 Pieces, Light, with Ammunition Boxes, and 5½ Inch Howitzer do.	_____	2 3 0
Carriages for 5½ Inch Howitzer of 10 Cwt.	_____	3 2 0
Do. for 8 Inch do. common	_____	3 7 2
Sling-Cart complete	_____	3 0 2
Forge-Cart, with Limber	_____	4 0 0
Pontoon and Carriage, with Appurtenances	_____	11 0 0
Ammunition Waggon	_____	4 18 1
Gravel Cart	_____	2 16 2
Duke of Richmond's clofe-bodied Waggon	_____	5 0 0
Road Waggon, with upright Sides	_____	7 10 0
Gin; Triangle complete	_____	0 14 0
Grate for heating Shot	_____	0 4 2
Hand-Spikes	120	1 0 0
Hand-Crows, Lever of 5 Feet	120	1 0 0
Hand-Screws		
Do.	Large 15	1 0 0
	Small 17	1 0 6
Helves, Picking or Felling	300	0 14 0
Do. Sledge	300	1 0 0
Do. Pin-Maul	360	1 0 0
Junk	Cwt. 20	1 5 0
Linstocks, with Cocks	600	1 0 0
Do. without	1000	1 0 0
Musquets, a Chest of 25 is 16 Cubic Feet.		
Do. Do. of 20 is 11 do.		
Match	Cwt. 6	1 14 0
Powder, whole Barrels	11	1 0 0
Do. half do.	22	1 0 0
Pitch or Tar, 1 Barrel is 7 Cubic Feet.		
Pistols, a Chest of 50 or 60 is 10 Cubic Feet.		
Park-Pickets	40	0 9 1
Pikes	280	1 0 1
Sheep-Skins	Dozens 12	1 1 0
Shovels, } of Iron {	100	1 0 0
Spades, }	184	1 0 0
Shovels shod with Iron	138	1 0 0
Sand-Bags, in Bales, 1 Bushel	500	0 12 0
Do. half Bushel	500	0 7 1
Do. 2 Bushels	250	0 8 1

## EMBARKATION.

When ordnance and stores are embarked, all appertaining to the same species should be classed and divided into the several vessels, in such manner as may insure the safe arrival of a certain portion; thereby avoiding that great inconvenience which could not fail to arise, were any one vessel, containing the whole of any particular stores, to be lost, taken, or unable to make the place of destination. With each piece of ordnance should be embarked every thing necessary for its service; so as to be instantly come at, when required to be landed. This principle should be carried to the fullest extent: even the platforms for the battering cannon should be in the same vessel with them; and, in short, every precaution ought to be taken to obviate delay, or omission, or imperfection. In general, all the heavy stores should be put in first; both to prevent their crushing less substantial articles, and to serve as ballast: the lighter stores, being generally most perishable, should be stowed uppermost, and be all numbered according to their several natures, and to their several intentions. Thus, every piece of ordnance, its carriage, and even all the parts of that carriage, together with its sponges, rammers, limbers, and boxes, ought to bear the same number; so that, when about to be landed, the whole may be discharged at one time from the ship, and be sent on shore in that regular manner, which may enable the artillery men and artificers to mount every one in succession with promptness and exactitude. All the chests, barrels, &c. must be lettered and numbered distinctly, in such manner as may indicate their respective contents. The numbers, &c. ought to be painted in clear white on a black ground, thereby to be legible at night: for the same purpose, it would perhaps be found useful to have the letters marked with white-headed tacks; so that, when not legible, for want of light, as often happens, they may be traced with the finger. In shipping gun-carriages, it is eligible to send them down into the hold, &c. without taking off the axle-trees from the cheeks; as they cannot be replaced without proper workmen, and a tedious operation. When a carriage is dismounted, all the small articles, such as elevating-screws, lynch-pins, drag-washers, &c. should be carefully collected, and secured either in a small box, or in a bag of leather, tarpaulin, &c. duly marked.

In order to give more room, all articles, of the same description in particular, should be placed so as to lock into each other, or to fit in such manner as may leave the least possible intervals. A person should attend to register, not only the several articles as they should be shipped, but to note the exact part of the hold, &c. where each might be stowed. These precautions, added to the affixment of particular marks, such as numbers, in white paint, on each bow, and each quarter of every transport, so as to be distinguishable at several miles distance, will tend considerably to facilitate the debarkations; and enable the several commanders and public officers to ascertain with perfect precision the amounts of losses, and the situations of the several stores, according as vessels may lie to windward, or to leeward, &c. It is a matter of considerable importance in embarking stores, to have them ready at hand which would be the first wanted in case of emergency: as well as to arrange them in such manner as should answer the purposes of the expedition in the most efficacious manner. Thus, if it is expected that troops will have to disembark in the presence of an enemy, the light field-pieces, and howitzers, in lieu of being sent below, ought to be kept, together with all their implements, and a certain portion of their ammunition in some secure part, whence they could be lowered into the boats at a short notice. Entrenching tools should

also be held in equal readiness, together with abundance of sand-bags. When troops are to be embarked, every precaution must be taken to prevent confusion, and to obviate danger. Certain corps should be appointed to be in readiness on given days at particular ports; taking with them only such baggage as should be allowed on the occasion. The stores of every description and the disposable lumber should be previously sent on board, under charge of the quartermaster, who should be particular in seeing that every thing necessary to the comfort and efficiency of the troops were duly arranged. The transports being in readiness, they should, if possible, be brought up to a pier, so that, by the aid of gang-boards, the files might march on board at once; otherwise recourse must be had to boats and small craft, in which the troops must proceed from the shore to the shipping. The lee-side is generally preferred for embarking; it being the smoothest water, and often the ascent up the gang-ladder less difficult. The safest mode is for the arms to be handed up into the main chains, and from thence into the vessel. The bayonets ought to be well secured to their scabbards, and the pouches should be buttoned down. The men nearest the gang-ladder should be the first to ascend; the others taking care to balance the boat, &c. as she becomes lighter, and requiring equipoise in consequence of being quitted by the troops. It should be observed as a standing regulation never to let one boat lie abreast of another that is discharging her crew into a vessel: otherwise there will not only be danger of broken-legs, but of being upset: each boat should range up under the lee-quarter, in succession, and when evacuated by the troops should pull a-head, by means of a painter, or a boat-hook, so as not to impede its successor. When the troops are on board boats, they should sit as low as possible, keeping their muskets perpendicular, and rested on the bottom, or on their own feet. In going on board the men should proceed very leisurely and silently to their places, spreading so as to preserve the due time of the boat, and sitting down so soon as duly arranged. In case of accident, or running foul of any other vessel, they should be particularly enjoined to remain seated, and not to obstruct the boat's crew in their endeavours to remedy the mishap. Where troops are to embark in the face of an enemy, the greatest order and coolness will be requisite; especially when within the reach of their cannon. If the embarkation in boats is to be made from a ship, they must all be manned from that side least exposed to the enemy's fire; the ship covering them as they successively put off, and rest on their oars, until the whole may be ready to start together by signal; after which no time should be lost in gaining the shore, and in forming on the beach. It sometimes occurs, that a river is to be crossed in boats for the attack of an enemy posted on the opposite bank: in such case, the number of boats being previously ascertained, the troops must be told off into as many divisions as there may be vessels to convey them, the strength of each division corresponding with the tonnage of that it is to occupy. Each division then proceeds on board with rapidity, but with perfect regularity, and the whole put off without delay. Where the water is rather shallow, the boats must lie out so far as to be afloat after the men have, by wading, got on board. All debarkations from boats and shipping should be conducted with as much order as circumstances may admit; and even when troops are driven back to their boats, as much should be preserved as the pressure of pursuit may allow. It is a well-known fact, that many re-embarkations have taken place in the presence of a superior force without disorders, or allowing the enemy to make a single prisoner. The greatest danger generally

arises

arises from allowing the boats to lie in so close, as to touch the ground, whereby, when the troops have got on board, they have been unable to push off, and thus remained subject to a galling fire. When re-embarking after a repulse, it should be studied to man some of the craft, (especially a few of the lightest construction, and any gun-boats whose draught of water may allow them to lie near the beach,) for the purpose of covering the retreat, and to take in flank such of the enemy as should follow the fugitives into the water. When such a precaution is observed, the embarkation will proceed quickly, and the enemy will content themselves with a distant fire on the retreating force; in lieu of mixing pell-mell, as they would do if there existed no pre-established check. Troops embarked on board transports, or ships of war, are only allowed three-fourths of a seamen's ration of provisions; unless when acting as marines, when they are on a footing. The messes are formed of six men in each, for each of which a space of six feet square is allowed, that is, 36 square feet; but only four are ever there at the same time, it being a rule that one-third of each mess should always remain on deck. When embarked for foreign service, six women are allowed provisions for every hundred men; and when on home service, ten women are allowed with the same number. That part of the charter-party which relates to the provision, firing, candles, utensils, &c. intended for the use of the troops, is always subject to the inspection of their commanding officer on board; and is sometimes copied out, and hung up in the cabin, open to the perusal of all. The regulations regarding smoking, extinction of lights, &c. are also posted up in various parts, together with the whole allotment in regard to births, messes, and particularly the accommodations for the officers of the vessel, and those attached to the troops. It being necessary to establish some limit for the quantities of baggage taken on board, the following proportions were fixed for that purpose.

For a field-officer	-	-	five tons.
For a captain	-	-	three tons.
For a subaltern	-	-	a ton and a half.

General officers are rarely limited, but it is usually intimated to all embarking, that the quantity of baggage should be reduced as much within bounds as might be practicable.

The embarkation of horses is usually effected by means of slings of canvas, which passing under their bellies, and being duly secured with cords, enable the crew to hoist them in, and to lower them down between decks without doing the smallest injury to the animals; which, however spirited they may be while on terra firma, generally become perfectly passive under such circumstances. On arriving at the place of destination they are debarked in the same manner. It certainly is among the most important improvements in this branch of service, that the horses can be slung, during bad weather, to the beams in such manner as to prevent their suffering in consequence of the ship's motion. Yet we cannot but judge, from the crippled state in which cavalry are sometimes debarked, that much room remains for improvement.

**EMBARRAS, EMBARRASMENT**, a French term, though now naturalized; denoting a difficulty, or obstacle, which perplexes or confounds a person, &c.

**EMBASIS**, in the writings of the *Ancient Physicians*, the name of a large vessel, in which they prepared their medicated baths, and which was capable of holding the person to be bathed at his full length.

**EMBASSADOR**, or **AMBASSADOR**, is a public minister.

ter sent from one sovereign prince or independent state to another, as a representative of that prince or state, and furnished with credentials which verify his mission as an ambassador.

Such a public minister is called in Latin *legatus*, or *orator*, but the meaning of the word ambassador is much more extensive. The only circumstance in which the modern ambassador and the ancient *legatus* agree is the protection of the law of nations. See **LEGATION**.

The English word ambassador is probably derived from the Spanish *embaxador*, the same as the French *ambassadeur*, which comes from *ambasciator*, a Latin word of the middle age, formed of *ambascius*, or *ambasci*, an agent, domestic, or client among the Gauls. The term *ambascia* is found in the Salic law, Tit. xix. and in the law of Burgundy.

The custom of sending ambassadors dates from the origin of civil societies. As soon as mankind were divided into distinct nations, differences would arise which must be amicably settled by the interference of neighbours, guarded against by the protection of the more powerful, or decided by wars ending in reconciliations. The negotiating of these mediations, alliances, and treaties of peace is entrusted to public ministers; and sovereign princes having, like private persons, interests to discuss with other princes regarding their own concerns as individuals, such as the contracting of matrimonial alliances; the management of these transactions is likewise confided to public ministers, or negociators. See **NEGOCIATION**.

Among the public ministers sent as negociators, from one independent state or sovereign prince to another, ambassadors hold the first rank. Envoys, ministers plenipotentiary, and residents, are negociators of less eminence. (See **ENVOY**, **PLENIPOTENTIARY**, and **RESIDENT**.) Their functions are the same; they are equally under the protection of the law of nations, and they enjoy nearly the same privileges.

The pre-eminence of ambassadors manifests itself chiefly in the particular ceremonial of their reception in the country where they are appointed to reside. They are entitled to be saluted with the firing of guns; to be complimented by deputies of the prince or state to which they are sent; to make a solemn public entry; to speak at the audiences they obtain with their heads covered; to have places of honour assigned to them at all public ceremonies; to keep a canopy or throne in their dwelling; and, since the year 1593, when this title was first given them at Rome, to be styled excellencies. The name of ambassador, Cicero observes, is sacred and inviolable: "non modo inter sociorum jura, sed etiam inter hostium tela incoluma versatur;" (In *Verr. orat.* 6.)

The privileges which ambassadors share with other public ministers, sent as negociators, are.

1. The right of being received by the prince or state to which they are deputed, unless there be a just cause for refusing to receive them. The duke of Buckingham, says Hume, had English familiarity, and French levity, two of the most offensive qualities in an ambassador. When, in 1626, he was desirous of being once more ambassador at the French court, it was signified by the French ambassador to the court of St. James's that for reasons well known to the duke his person would not be agreeable to his most Christian majesty. His presumption to talk of love to the queen in a former embassy had given offence, and would have been a just cause for his non-admission.

The corresponding obligation of receiving foreign ambassadors has its foundation in the dearest interests of society and of humanity. As nations are in continual need of mutual assistance, they could never freely communicate, if the

law of nations had not made it an imperious duty to all states to admit the ambassadors who are sent to them. Even the ambassadors of an enemy have a right to be received and to be heard, since it is the duty of nations at war with each other to endeavour by all possible means to re-establish the accustomed relations of peace and amity.

2. The inviolability of their persons. Ambassadors represent the sovereign or chief magistrate of an independent state; their missions are frequently of the most delicate nature, and could not be accomplished if the security of their persons were not expressly provided for. Those who insult an ambassador infringe not only the civil law, which forbids the doing of injuries in general, but more particularly the public law of nations, which extends its special protection to public ministers, that the harmony of nations may not be disturbed, or if unfortunately the ties of friendship have been broken, that the effecting of a reconciliation may labour under no restraint. The smallest insult offered to an ambassador ought to be punished with the greatest severity; the neglect to punish the offender is a just cause of war.

If an ambassador grossly offends, or makes an ill use of his character, he may be sent home, and accused before his master: who is bound either to do justice upon him, or avow himself the accomplice of his crimes. (Mont. Sp. of L. 26. 22.) But writers on the law of nations are not agreed, whether this exemption of ambassadors extends to all crimes, as well natural as positive: or whether it only extends to such as are *mala prohibita*, as coining, and not to those that are *mala in se*, as murder. Our law seems formerly to have taken in the restriction, as well as the general exemption. For it has been held, both by our common lawyers and civilians (1 Roll. Rep. 175. 3 Bulst. 27.) that an ambassador is privileged by the law of nature and nations; and yet if he commits any offence against the law of reason and nature, he shall lose his privilege (4 Inst. 153.); and therefore, if an ambassador conspires the death of the king in whose land he is, he may be condemned and executed for treason; but if he commits any other species of treason, it is otherwise, and he must be sent to his own kingdom. However, the general practice of this country, as well as of the rest of Europe, seems now to pursue the sentiments of the learned Grotius, that the security of ambassadors is of more importance than the punishment of a particular crime. And therefore few, if any, examples have occurred within a century past, where an ambassador has been punished for any offence, however atrocious in its nature.

Even the domestics and the persons in the retinue of an ambassador are inviolable. If any one of them were insulted, the punishment ought to be as severe as if the insult had been offered to the ambassador himself. The domestics of the duke of Créqui, French ambassador at Rome, having been insulted by the Corsican guards of Pope Alexander VII. Louis XIV. insisted upon their being severely punished.

But this inviolability extends only to the persons who compose the ambassador's family, as his wife and children, and who being actually in his retinue are registered as such by the police of the country where he resides. Should, however, any of them be guilty of a great crime, as a forgery, theft, or murder, it would be no violation of the law of nations to claim the offender, and to punish him according to the laws of the country. When Sully resided in England as ambassador of Henry IV of France, he was informed that one of his gentlemen had killed an Englishman in a house of ill fame. He immediately got him arrested, and sent word to the magistrates of London that they might

seize the murderer. The latter having been tried, the king of England granted him his pardon and his liberty.

In consequence of this inviolability the actions of an ambassador or of any person in his retinue are not subject to the controul of the private law of the country in which he is appointed to reside; and with regard to civil suits they cannot be prosecuted for any debt contracted in that country as long as the ambassador continues in it in his public capacity. This privilege is allowed in the English courts of law, and, the more effectually to enforce the law of nations in this respect, when violated through wantonness or insolence, it is declared by the statute 7 Ann. c. 12. (an act passed in 1708, in consequence of the arrest of an ambassador from Peter the Great, czar of Muscovy, for a debt of 50*l.*) that all process whereby the person of any ambassador, or of his domestic or domestic servant, may be arrested, or his goods distrained or seized, shall be utterly null and void; and that all persons prosecuting, soliciting, or executing such process, being convicted by confession or the oath of one witness, before the lord chancellor and the chief justices, or any two of them, shall be deemed violators of the laws of nations, and disturbers of the public repose; and shall suffer such penalties and corporal punishment as the said judges, or any two of them, shall think fit. But it is expressly provided, that no trader, within the description of the bankrupt laws, who shall be in the service of any ambassador, shall be privileged or protected by this act; nor shall any one be punished for arresting an ambassador's servant, unless his name be registered with the secretary of state, and by him transmitted to the sheriffs of London and Middlesex. These exceptions are strictly conformable to the rights of ambassadors, as observed in the most civilized countries. In consequence of this statute, thus declaring and enforcing the law of nations, these privileges are now held to be part of the law of the land, and are constantly allowed in the courts of common law. (Fitz. 200. Stra. 797.) Blackstone's Commentaries, vol. i. and iv.

3. The most perfect freedom and independence in the discharge of their official duties. This is a further consequence of their inviolability. If an ambassador should even excite disturbances, or enter into any conspiracy against the prince, or the state to which he is sent, the general practice of Europe is in favour of the opinion of the learned Grotius, in his book "De Jure Belli et Pacis," that the inviolability of an ambassador is of greater importance than the punishment of a particular crime. His public character ought to be constantly and invariably respected; but he may be dismissed, and sent back to the prince or state whose representative he is. The bishop of Rois, ambassador of the queen of Scotland at the court of Westminster, having engaged in a conspiracy with the duke of Norfolk against the queen, he was arrested, confronted with his accomplices, and sent back to Scotland. In the reign of Henry IV. of France, the Spanish ambassador took a part in the conspiracy of the count d'Auvergne and duke d'Angoulême, who were both tried; but no mention was made of the ambassador. A certain Mérargues had agreed, with the secretary of the same ambassador, to deliver Marseilles into the hands of the Spanish monarch. The French parliament condemned Mérargues to death; but the Spanish secretary was delivered to the king of France, who gave him up to the Spanish ambassador, and obliged the latter to send the secretary out of the kingdom.

If an ambassador be dismissed and escorted to the frontiers, he is entitled to the privileges and immunities of his dignity, as long as he is on the territory of the state that sends him back. He ought also to be allowed a convenient time

to prepare for his departure. This indulgence must even be granted to the ambassador of a power against which a declaration of war has been issued, and he must be furnished with passports to return home unmolested. The custom of the Turks, who, in the case of war being declared, confine the ambassador of the power against which it is declared in the castle of the Seven Towers, is in direct violation of the law of nature, and of the public law of nations. The enlightened sovereigns of Europe should join in remonstrating against so unjust a practice, and insist upon its abolition.

4. The inviolability of the house in which they reside. An ambassador's dwelling is a sacred asylum, where no person can be arrested without the ambassador's consent. Any felon, however, that might have taken refuge in an ambassador's house, ought to be given up to the criminal justice of the country.

Neither have ambassadors the right of trying or punishing, within the walls of their mansion, persons of their retinue who have been guilty of any crime. Though independent of the criminal and civil laws of the country in which they reside, they cannot exercise any judicial functions, because the judicial power of the sovereign they represent does not extend to that country.

5. The right of having divine service performed in their houses, at a chapel of their own, according to the rites of the worship of their country: but ambassadors cannot claim the free access of others to their chapel than the subjects of the country they represent, who are under their special protection in this respect. At the time when the Protestants were cruelly oppressed and persecuted in France, the French Protestants residing at Paris have frequently been molested in going to and coming from the chapel of the Dutch ambassador; but he had no right to remonstrate against this cruelty, because it was exercised on the subjects of the king of France.

6. The right of being exempt of all duties, charges, taxes, imposts, excise and custom dues. This right has sometimes been restricted in countries where it had been abused by ambassadors, who, forgetful of their dignity, had not scrupled to make it a cover to an illicit trade.

7. The privilege, that in case of death, the household furniture, moveables, and personal property of ambassadors, or of any individual in their retinue, devolve to their heirs, though aliens, without being liable to any deduction, tax, or alien duty, commonly called "Droit d'Aubaine." But this right does not extend to immoveables, or landed property.

8. The right of legalizing or certifying the authenticity of documents or writings which are to be transmitted to the state or country which they represent, and that of granting passports to the natives of that country.

9. The right of following the court at which they are appointed to reside, to whatever place that court is removed to, unless the prince should declare his absence to be merely temporary, and request the ambassador's non-attendance. During the seven years' war in Germany, from 1756 to 1763, the English ambassador at the court of Berlin attended the great Frederick of Prussia at all his headquarters.

10. Lastly, ambassadors consider themselves as entitled, and indeed custom appears to have sanctioned it as a right, to receive some valuable trinkets as presents at their last audience, when they take leave of the prince at whose court they have resided.

Embassadors ought to be very attentive not to suffer any of their privileges or immunities to be infringed upon; neither ought they to pass over any attack on the person or

dignity of the prince, or on the character of the state they represent. Whenever they have a complaint of a breach of privilege to prefer at the court where they are appointed to reside, they are supported in their demands of redress by the whole diplomatic body, or corps diplomatique, that is to say, by the aggregate of all the foreign ministers residing at the same court.

But ambassadors cannot claim their privileges and immunities, unless they have proved their mission as ambassadors by the delivery of their credentials; nor can they display their character of public ministers in any other country than that to which they are sent in that quality. When they are under the necessity of traversing the dominions of any other sovereign prince, they must provide themselves with the permission to travel through that country by means of regular passports, for the law of nations does not oblige a prince or nation to respect an ambassador on his journey through their country, if he should attempt to traverse that country without having previously obtained their permission.

At Athens the ambassadors from foreign princes and states always mounted the tribunal, or pulpit, of the public orators, and there opened their commission, and acquainted the people with their business. At Rome they were introduced to the senate, and delivered their commission to them. Among us they make their address immediately and solely to the king.

Athens and Sparta, says M. Tourneil, when in all their glory, were never so much delighted as to see and hear a number of ambassadors in their assemblies, suing for their protection or alliance. It seemed to them the noblest homage that could be paid them; and that state which received the most embassies, was judged to have the advantage over the other.

There are some usages to which ambassadors ought to conform. They should never attend at any marriage, christening, funerals, or other private solemnity; nor must they even go into mourning on any occasions of their own, because they are no longer private individuals; they are the representatives of a sovereign prince or independent state.

Embassadors, in modern times, are either *ordinary* or *extraordinary*.

An *ambassador ordinary* is he who constantly resides at the court of a sovereign prince or independent state, to maintain a mutual good understanding between the two states, to watch over the permanent interests of his country, to transact such affairs as may occur, and to give a regular account of his proceedings and observations to the prince or state which he represents. The practice of keeping ambassadors ordinary in foreign courts is but of modern invention. It is generally ascribed to the cardinal de Richelieu. Raymond de Beccaria, baron de Forquevaux de Pavie, knight of the order of St. Michael, was one of the first public ministers who resided permanently at a foreign court. He was sent to Spain in 1565, as ambassador ordinary of Charles IX. of France at the court of Philip II. probably on account of the misunderstanding which prevailed between the Spanish monarch and his consort Elizabeth, who was a French princess.

The frequent intercourse which takes place between modern nations; the many relations in which they stand to each other; their mutual interests; their political and commercial jealousies; the wish of being rapidly and confidently informed of their respective projects, enterprises, connections and partialities, of the springs by which their governments are set in motion, and of the general administration

## EMBASSADOR.

of their concerns abroad and at home; and lastly, the want of a powerful protection for individuals trading in foreign countries, are indeed circumstances which confer on the permanent residence of public ministers in foreign courts a high degree of public convenience and utility. Every independent European state has adopted the practice, except the Helvetic Republic, and the sublime Ottoman Porte. These two states have hitherto at least employed only ambassadors extraordinary.

An *ambassador extraordinary* is he who is sent from one sovereign prince or independent state to another on some particular occasion or emergency, and who retires as soon as the business of his mission is terminated. Hence it follows that an ambassador extraordinary may be dispatched to a court or country where an ambassador ordinary of the same prince or state is permanently residing. Thus the king of Great Britain appointed Mr. Rose ambassador extraordinary to the United States of America in 1808, for one particular purpose, whilst the honourable Mr. Erskine continued as British ambassador ordinary at Washington.

In ancient times, all embassies were extraordinary. They were generally undertaken from motives of necessity, policy, or adulation, sometimes even from the mere love of magnificence, and commonly composed of a great number of ambassadors. This used also to be the case with the extraordinary embassies of the Swiss, because every canton appointed its ambassadors. The embassy which Switzerland sent to the king of France in 1663, consisted of forty-two ambassadors.

In our days, extraordinary embassies of more than one ambassador, are very rare; at least they never consist of more than three ambassadors. Their number, however, is noways limited by the public law of Europe; neither is the retinue or train of an ambassador extraordinary restricted to any particular number of persons. It ought only not to be so numerous as to create any uneasiness in the country where the ambassador extraordinary is appointed to sojourn for a short time. The duke of Feria, who went to France as ambassador extraordinary of the king of Spain, to compliment Louis XIII. on his accession to the throne, after the death of Henry IV. had so numerous a retinue, that the governor of Bordeaux refused to admit him in that city. He assigned him his quarters in one of the suburbs, and wrote to inform him, that he could not admit him in the place, because his train formed a small army, which might easily assail the governor with a thousand firelocks. This cautious conduct of the governor was fully approved of at the French court.

Extraordinary embassies are generally very brilliant. The earl of Manchester's public entries into Venice as extraordinary English ambassador in 1698 and 1701, are described as uncommonly magnificent. His excellency was attended by sixteen footmen, and six pages, dressed in velvet and gold brocade, besides his secretary, and a considerable number of English gentlemen.

The ambassador extraordinary has the precedence before the ambassador ordinary of the same power. When it happens that an ambassador extraordinary is sent to the same court after another ambassador extraordinary, he who is last arrived has the precedence, unless the prince or state by which they are appointed determines their rank differently. When ambassadors ordinary are relieved, he who is going to quit the court or country where he has resided walks at the right of his successor in proceeding to the audience: but, in returning, he gives the right to the new ambassador, because his functions are terminated by the farewell audience.

With respect to the rank of foreign ambassadors residing at the same court among themselves, the nuncio of the pope was always considered as holding the first rank at the French court before the establishment of the French republic in 1792. He used to compliment the king on particular occasions in the name of the whole diplomatic body. In other courts the French ambassador had the precedence before the ambassadors of any other kingdom. The Spaniards alone disputed his pre-eminence for a time: but it was solemnly recognized by Spain in 1662, and no other power did ever dispute it. The French ambassador claimed even the precedence before the Russian imperial ambassador. M. D'Esterno, the French ambassador at the court of Berlin in 1786, found himself highly offended, that the queen of Prussia, consort of the late Frederick William II. sat down to cards with the Russian ambassador, whilst he was only invited to take a hand with the princess Friderika, eldest daughter of the king of Prussia, at present duchess of York.

The right of sending ambassadors is generally vested in the prince or chief magistrate, to whom the exercise of the executive power is entrusted in independent states. It is an essential attribute of sovereign power. Yet it is not absolutely necessary that a prince be in the actual possession of this power to appoint ambassadors; provided he have not abdicated the crown, his ambassadors ought to be received at other courts, unless there be some political motives for refusing their admission: but even in that case they are like other public ministers, under the special protection of the public law of nations.

The actual possession of the sovereign power, whatever may have been the means by which it has been acquired, is considered as a sufficient title to the right of sending ambassadors, and the ambassadors of an usurper have often been admitted in courts where those of the lawful prince have been refused. The ambassadors of Cromwell were received in France, when Charles II. himself could not obtain an audience.

To admit an ambassador, is to acknowledge the sovereignty of the prince, or the independency of the state which he represents. France acknowledged the independence of the United States of America, by admitting Franklin as their ambassador before they were declared independent by Great Britain.

During the minority of a monarch the regent may appoint ambassadors, but always in the name of the king. They represent him in whom the executive power is vested by the constitution and not his substitute. It is this representative dignity which subjects the proceedings and motions of ambassadors to formalities and ceremonies that frequently impede and obstruct their negotiations. Hence it is not unusual to appoint a simple minister plenipotentiary to carry on an important and difficult negociation, but to furnish him at the same time with the credentials of an ambassador extraordinary, with the strict injunction not to make any use of them unless he should be successful in his mission. In that case he delivers them only at the close of the negociation, just before the signing of the treaty, which derives a certain additional solemnity for being signed by an ambassador extraordinary.

As the functions of an ambassador consist in watching in the country where he is appointed to reside over the interests of the state which he represents, in making regular reports of his proceedings, and in communicating every circumstance, the knowledge of which is deemed of importance to the minister at the head of the department for foreign affairs in his own country, it follows that an ambassador ought to be well acquainted with the political state and

the language of the country in which he resides, with the temper and disposition of the prince or chief magistrate by whom it is governed, with the particular character of the minister who manages its foreign affairs, with the relations of that country with the other powers of Europe, and with the particular policy which influences them towards that country. To this indispensable political information an ambassador ought to join a consummate knowledge of mankind in general, an incorruptible integrity, an enlightened prudence, a sagacious judgment, mild and refined manners, an insinuating address, a generous disposition, sound discretion, and dignified firmness, and above all a great command over himself. This catalogue of qualities, which are rarely combined, shews how difficult it must be to find fit subjects for embassies. There is in France a sort of diplomatic gradation through which all individuals employed in missions to foreign courts are generally obliged to pass. The first step is that of secretary of legation of the second class, then follows that of secretary of legation of the first class; the third step is that of minister plenipotentiary, and the fourth that of ambassador. Frequent exceptions, however, take place with regard to the appointment of ambassadors, who are sometimes taken from the army. (Wicquefort. *Pembassadeur et ses fonctions*. Pecquet. *discours sur l'art de négocier*. L'esprit de Leibnitz, tome ii. Chesterfield's letters ccii. ccxix. elii. cclxxxviii.)

EMBASSADRESS, in French *Ambassadrice*, is, in the common acceptation of the word, the wife of an ambassador, who as such shares his rank and privileges. But there have been ambassadresses in their own right, or female ambassadors. The famous league of Cambray was signed, in 1508, on the part of the emperor, by Margaret of Austria his daughter, to whom he had given full powers for that purpose. The peace concluded at Cambray, in 1529, in confirmation of that of Madrid, was also signed by the same Margaret of Austria, duchess of Parma, in the name of Charles V. and by Louisa duchess of Savoy, mother of Francis I. by virtue of full powers given to these two illustrious ladies by the emperor and the king of France. In the year 1645, Louis XIV. expressly appointed Madame la Maréchale de Guébriant his ambassadress extraordinary, to consign Mary de Gonzagues, daughter of the duke of Nevers, to the arms of her royal husband, the king of Poland, who had married the princess by procurator. Circumstances might indeed arise in which a lady might with great propriety be appointed ambassadress at the court of a sovereign princess, into whose confidence she might more easily insinuate herself than an ambassador. In such cases she would be under the special protection of the law of nations, and enjoy all the rights and immunities of an ambassador.

EMBASSY, formerly *Embassage*, in French *Ambassade*, *legatio*, is the charge or office of an ambassador, or any other public minister sent to represent one sovereign prince or independent state at the court of another. It also denotes the solemn message, mission, or errand, on which such a public minister is sent.

F. Daniel observes, that under the ancient French kings, their embassies consisted of a body, or number of persons, joined together in commission, and who composed a kind of council; something like which is still retained at treaties of peace. Thus the French embassy at Nimeguen, for the peace consisted of three plenipotentiaries; that of Utrecht, of two, &c. See EMBASSADOR.

EMBATTLED, a term in *Heraldry*, when the outline of any ordinary is notched so as to represent the battlements of a wall, or castle. See BATTLEMENT.

None were suffered, in ancient times, to embattle their houses, but those who had great dignities, as the barons, and the like. Camden proves this in his account of Tunstall's seat in England, in which he expresses it as a signal mark of the royal favour, that he had liberty given to embattle it. The heralds express this embattled line by the term *crenelle*; and when it has the embattling on both sides, which is the more rare, they call it *brétesse*; which see.

EMBAUL, in *Geography*, a town of Africa, in the kingdom of Damel. N. lat. 15° 15'. W. long. 15° 37'.

EMBDEN. See EMDEN.

EMBELIA, in *Botany*, corrupted from the Ceylon name Aembillia. Burm. Ind. 62. t. 23. Juss. 427. (Ribesioides; Linn. Fl. Zeyl. 190.) Class and order, *Pentandria Monogynia*. Nat. Ord. uncertain. Juss.

Gen. Ch. Cal. Perianth small, five-cleft, inferior. Cor. Petals five, regular, undivided. Stam. Filaments five, equal; anthers . . . . Pist. Germen simple, superior; style one; stigma . . . . Peric. Berry . . . .

A smooth shrub, without thorns. Leaves alternate, oblong, entire. Flowers in terminal panicle clusters. Fruit white, acid, used for making rob or jelly. Native of Ceylon. Schreber, by his index, seems to refer this plant to *Anidefina*, but their characters do not accord.

EMBER-GOOSE, in *Ornithology*, the *colymbus immer* of Linnæus; which see.

EMBER-WEEKS, are those wherein the ember or embering days fall.

In the laws of king Alfred, and those of Canute, these days are called *ymbren*, that is, *circular days*, from whence the word was probably corrupted into ember days. By the canonists, they are called "quatuor anni tempora," the four cardinal seasons, on which the circle of the year turns; and hence Henshaw takes the word to have been formed, viz. by corruption; from *temper*, or *tempora*. The ancient fathers called them "quatuor tempora jejunii."

Mr. Somner thinks they were originally fasts, instituted to beg God's blessings on the fruits of the earth. Agreeably to which, Skinner supposes the word ember taken from the ashes, embers, then strewed on the head.

The ember days are the Wednesday, Friday, and Saturday, next after Quadragesima Sunday, or the first Sunday in Lent, after Whitsunday, after Holyrood-day in September, and after St. Lucy's day in December; which four times answer well enough to the four quarters of the year, spring, summer, autumn, and winter. These days are mentioned by Britton, c. 53, and other writers; and particularly in the stat. 2 and 3 Edw. VI. c. 19.

These ember weeks are now chiefly taken notice of on account of the ordination of priests and deacons; because the canon appoints the fundays next succeeding the ember-weeks for the solemn times of ordination; though the bishops, if they please, may ordain on any Sunday or holiday.

EMBERIZA, in *Ornithology*, a genus of the Passerine order, the character of which consists in the bill being couic; mandibles receding from each other from the base downwards, the lower with the sides narrowed in, and a hard knob within the upper mandible. This last-mentioned process in the mouth is adapted in a very peculiar degree to the manners of the emberiza tribe; all the species feed on seeds, and by the aid of this knob they are able to break and comminute the shells of the harder kinds with facility. The genus is extensive, and includes some very beautiful birds.

Species.

## EMBERIZA.

### Species.

**NIVALIS.** Quill-feathers white, primaries black on the outer edge; tail-feathers black, the three lateral ones white. Linn. *Hortulanus nivalis*, Briss. *Ortolan de neige*, Buff. *Pied mountain finch*, Albin. *Snow bunting*, Lath. *Donov. Brit. Birds.*

Inhabits the northern parts of Europe, Asia, and America, during summer, and migrates to warmer climates in the winter. Its size rather exceeds that of the chaffinch; it builds in cavities of rocks and lays five eggs, which are of a white colour, spotted with brown. The species varies considerably in its plumage at different seasons of the year, and three distinct kinds are described as permanent varieties. One variety is white, with the feathers dashed with yellow, and the chin and throat marked with very small brown spots. This is called by Frisch Weis's Fleckige Ammer. Another (*hortulanus nivalis pectoris nigro* of Brisson), is yellowish-white above, beneath with the breast black; wings and tail black and white intermixed. The pied chaffinch of Albin is the third; the body of this is reddish-brown; head and neck white, breast with a blueish spot; wings and tail varied with black and white.

**MUSTELINA.** Quill-feathers dusky, white at the base, the last entirely black; tail-feathers black; middle ones at the edge, and three lateral ones each side, white with a dusky spot without. Gmel. *Emberiza nivalis*, Linn. *Emberiza glacialis*, Lath. *Tawny bunting*, Brit. Zool.

About the same size as the former, and is by some writers erroneously confounded as a variety of it. The species occurs rarely in the northern parts of Britain.

**MONTANA.** Five first quill-feathers blackish-brown, the rest white, spotted with brown at the tip; tail-feathers brown; three lateral ones each side entirely white. Gmel. *Lesser mountain brambling*, Willughby. *Mountain bunting*, Lath. *Donov. Brit. Birds.*

Found in Yorkshire and Lincolnshire.

**HYEMALIS.** Black, belly white. Gmel. *Fringilla hyemalis*, Linn. *Passer nivalis niger*, Kalm. *Ortolan jacobin*, Buff. *Snow bird*, Catesby. *Black bunting*, Lath.

The length of this bird is about six inches and a half. During winter, and more especially in snowy weather, it is seen in Virginia and Carolina; its summer place of residence is unknown. By some it is called the chuck-bird. The flesh is held in esteem as an article of food.

**MILIARIA.** Brown, beneath spotted with black; orbits rufous. Linn. *Alauda congener*, Aldr. *Strillozzo*, Olin. *Cynchramus*, Briss. *Gerst-ammer*, Gunth. *Le Poyer*, Buff. *Common bunting*, Lath. *Donov. Brit. Birds, &c.*

Common during the summer and autumn in most parts of Europe; in England they remain throughout the winter, but in the more southern climates migrate at the approach of that season. They associate in flocks. The females build their nest in a low hedge, or on a stump near the ground, and lay from five to six eggs. These birds are rather larger than the yellow-hammer, and in the appearance of their plumage so closely resemble the lark, that they are commonly sold under the name of bunting larks in the London markets. They are caught in vast numbers for sale during the winter season; the flesh is bitter, and inferior to that of the true lark.

**HORTULANA.** Quill-feathers brown, the first three whitish at the edges; tail-feathers brown, the two lateral ones black on the outer side. Linn. *Hortulanus*, Gessn. *Ortolano*, Olin. *Ortolan*, Lath.

The varieties of this species are numerous; the principal are  $\beta$  (*ortolan jaune* of Buff.); the plumage of which is yellowish,

with the quill-feathers edged with white;  $\gamma$  (*ortolan blanc*) snowy white;  $\delta$  (*hortulanus quintus* of Ray) which has the tail white; and  $\epsilon$  (*ortolan noiratre* of Buff.) the colour of which is blackish, head and neck greenish, bill red, and legs cinereous.

These birds are found chiefly in the south of Europe, from whence they migrate northwards as far as Sweden, but have not been known to visit England. The size is that of our yellow-hammer, and its song is not very dissimilar to the notes of that common bird, but more melodious; its nest is usually built in a low hedge, or on the ground, and contains five eggs of a greyish colour. The celebrity of the ortolan for the tables of epicures is perfectly well known; they are caught for this purpose in vast number at the times of their periodical migrations in spring and autumn, and fattened in a peculiar manner. Their feeders place them in a dark room, with an abundance of oats and millet, upon which they feed with avidity, and become in a very short time extremely fat, in which state they weigh sometimes three ounces each. When thus fed they are considered exquisitely delicious, and fetch a high price. Ortolans are taken in great numbers in the south of France and Italy, some parts of Germany, and the southern provinces of Russia and Siberia; and are potted or otherwise preserved, and form an article of exportation to those countries where these delicious birds are less commonly found.

**SINENSIS.** Reddish brown, beneath pale yellow; lesser wing-coverts yellowish; quill and tail-feathers with the longitudinal streak on the belly brown. Lath. *Ind. Orn.* *Ortolan de la Chine*, Sonner. *Chinese bunting*, Lath.

Inhabits the southern provinces of China during the months of October, November, and December. Size not mentioned.

**CITRINELLA.** Tail-feathers blackish, the two outer ones on the inner edge with a pointed white spot. Linn. *Emberiza flava*, Gessn. *Zivolo*, Olin. *Braunt*, Buff. *Yellow-hammer*, Ray. *Donov. Brit. Birds.*

A general inhabitant of Europe, in every part of which it appears to be common. The male differs from the female in having the colours of the plumage more obscure, and the head only tinged with yellow; in the male the head is of a very vivid yellow, whence its name. The nest of this common bird, as is well known, consists of hay, and other dry substances, slightly put together, and placed either on the ground or in a bush close to it: the eggs from four to five in number, and of a grey colour with streaks, and a few blotches of brown. These birds are eaten in Italy.

**OLIVACEA.** Olive, beneath whiter; chin orange; pectoral band blackish. Gmel. *Emberiza dominicensis*, Briss. *Olive*, Buff. *Olive bunting*, Lath.

Inhabits St. Domingo, and is about the size of the common wren.

**PASSERINA.** Above grey-ferruginous; middle of the feathers black beneath, whitish-ash spotted on the sides; tail-feathers black, the middle ones edged with ferruginous; the outer one each side nearly to the base, the next as far as the middle obliquely white. Pallas. *Passerine bunting*, Lath.

Size of the reed sparrow. The head and chin in the male black; behind the eyes a pale streak; tail rather forked; legs brownish flesh colour. Inhabits Russia near the Ural, and Jaick.

**PUSILLA.** Above grey-ferruginous; beneath whitish; throat spotted; head with alternate longitudinal testaceous and black bands. Pallas.

A small

## EMBERIZA.

A small species, found among the snowy mountains of Dauria.

**RUSTICA.** Head black, with three longitudinal white bands, chin, body beneath, and two outmost tail-feathers each side obliquely white. Pallas.

Inhabits Dauria, chiefly in woody situations.

**FUCATA.** Grey-ferruginous; ears with a round rufous spot; eye-brows, line beneath the eyes and throat white; chin furrounded with a brown spotted circle. Pallas.

Frequent in rocky parts of Siberia.

**SPODOCEPHALA.** Grey-ferruginous, beneath pale straw colour; frontlet black; head and neck hoary-ash. Pallas.

Inhabits near the waterfalls in the Alpine regions of Dauria. Size of the reed bunting.

**CHRYSOPHRYS.** Grey-ferruginous; crown black; eye-brows citron, from the middle of the crown to the nape a white band. Pallas.

Found with the latter; size of the common yellow-hammer.

**MAELBYENSIS.** Head and neck lead-cinereous; chin whitish; belly ferruginous. Sparman, Mus. Carl.

Described from a specimen taken at Maelby, in Sweden, a seat of count Carlson, in the dukedom of Sudermania. Some writers suggest that the bird mentioned might be either the female or young of the pine bunting.

**RUTILA.** Sanguineous rufous; beneath sulphur; wings grey rusty. Pallas.

Inhabits Siberia, and is the size of the yellow-hammer.

**FERRUGINEA.** Ferruginous; belly, and two spots on the primary quill-feathers, white. Arct. Zool. *Rufy bunting*, Lath.

Native of North America.

**AMERICANA.** Above cinereous, streaked with brown; beneath yellow; chin white; quill and tail-feathers black, with pale edges. Gmel. *Black throated bunting*, Arct. Zool.

Found in New York. Size of the yellow-hammer. The female is like the male, but has no black spot on the throat, nor streak of yellow above the eye. Dr. Latham describes a variety met with in Hudson's bay, the colour of which is ashy brown, beneath whitish, front and eye-brows yellow; band under the eyes, and the crescent on the front, black; chin, as in the male of the other, with a triangular black spot in the middle.

**BRASILIENSIS.** Crown, neck, and body beneath, yellow; back, wings, and tail greenish, varied with yellow and brown. Gmel. *Guiram beemgata*, Ray. *Guirnegat*, Buff. *Brazilian bunting*, Lath.

Size of a sparrow. The species inhabits Brazil.

**MEXICANA.** Above brownish, beneath whitish, spotted with brown; head and throat yellow. Gmel. *Thérese jaune*, Buff. *Mexican bunting*.

Length six inches and a half; the legs and bill pale; wings and tail brownish. Native of New Spain.

**MILITARIS.** Head, wings, tail, and back brown; lower part of the back and breast yellow; shoulders greenish; belly white. Hasselq. *Military bunting*, Lath.

Inhabits Malta.

**MELANOCEPHALA.** Yellow, head black; back rufous. Scop. *Black-headed bunting*, Lath.

Size of the yellow-hammer, and inhabits Europe.

**BRUMALIS.** Body beneath; front and region of the eyes citron; hind head and neck cinereous. Scop.

Native of the Tyrolese country. This and the two following are small species.

**COCCINEA.** Body above silvery, beneath crimson; vent white; bill, head, and quill-feathers black; hind head and tail black-blue. Sander.

Found in the woods about Baden.

**BADENSIS.** Olive, striated with blackish, beneath paler; throat orange; breast with black streaks. Sander.

Inhabits Baden. The bill is black above, beneath yellowish, with a single obtuse tooth in the middle.

**ERYTHROPHALMA.** Black, with a red gloss; belly reddish; wings with a white spot. Gmel. *Fringilla Carolinensis*, Briss. *Towhee bird*, Catesby.

This species inhabits Carolina, frequents shady woods, and is generally seen in pairs. Called by some the American bulfinch. Length eight inches.

**LEUCOPHRYS.** Rusty brown, beneath white; vent yellow; crown black, with a white fillet in the middle; eye-brows white. Forst. *White crowned bunting*, Arct. Zool.

Inhabits Canada, feeds on grass, seeds, and worms, sings melodiously, and lays three or four chocolate-coloured eggs. Length rather exceeding seven inches.

**LUCTUOSA.** Black; beard on the chest, front, breast, belly, rump, and vent white. Scop. *Wreathed bunting*, Lath.

Size of the greater titmouse.

**AUREOLA.** Rufous, beneath yellow; transverse pectoral band ferruginous; crown, cheeks, and chin black. Pallas. *Emberiza Sibirica*, Lepechin. *Yellow breasted bunting*, Lath.

Size of the reed sparrow, and inhabits the pine groves of Siberia.

**SANDWICHENSIS.** Brown, beneath whitish, spotted with brown; eye-brows yellow; temples dusky. Gmel. *Unalaska bunting*, Arct. Zool. *Sandwich bunting*, Lath.

Length six inches; bill and legs black; under the eyes a dusky line; middle of the belly whitish and immaculate. Native of Sandwich bay.

**AONALASCHKENSIS.** Reddish brown; beneath whitish, streaked with brown; middle of the belly white. Gmel.

Length seven inches, inhabits Aonalaschka, and resembles the former.

**ATRICAPILLA.** Chestnut, beneath cinereous; chin white; crown pale yellow, front and streak through the eyes to the nape black. Gmel. *Black crowned bunting*, Lath.

Native of the Sandwich islands; its neck is seven inches, the bill black, and legs brown. A variety is described in Cook's last voyage, which has the breast waved with black; the female without the yellow spot on the crown.

**PITHYORNUS.** Middle of the crown with an oval white spot; nape varied with white; chin red-testaceous; two exterior tail-feathers, each side with an oblique white band. Pallas. *Emberiza leucocephala*, S. G. Gmelin. *Emberiza alia species*, Lepechin. *Pine bunting*, Lath.

Inhabits the pine forests of Siberia, from the Uralian chain of mountains to the Lena; it lives among reeds on the shores of rivers, and passes the winter sometimes on the borders of the Caspian sea. The size is that of the yellow-hammer, and it has the note of the reed sparrow.

**CINEREA.** Bay, beneath whitish, spotted with bay; tail and quill-feathers brown, edged with grey; rump grey; tail-coverts reddish white. Gmel. *Emberiza canadensis*, Briss. *Cul-rouffet*, Buff. *Cinereous bunting*, Arct. Zool.

Length five inches and a half, and inhabits the juniper woods in Canada.

**CERULEA.** Rufous and blue varied; crown rufous; greater

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greater wing-coverts, quill-feathers, and tail-feathers, brown, with the outer edge rufous. Gmel. *Emberiza canadensis cerulea*, Briff. *Azuroux*, Buff. *Blue bunting*.

Inhabits Canada, and rarely New England. Its length is four inches and a half.

**CYANEA.** Blue; crown deeper; quill, and tail-feathers brown edged with blue. Lath. Ind. Orn. *Emberiza cyanea, redricibus fuscis*, Gmel. *Tanagra cyanea*, Linn. *Ministre*, Buff. *Blue linnet*, Catesby. *Indigo bunting*, Lath.

Size of the finch. The male, when in full plumage, is blue, at other times resembles the female, which is nearly throughout of a brownish colour; in the latter, however, the edge of the wing is tinged with green, and by this peculiarity the female may be distinguished from the male, the edge of his wing being blue. In Carolina, the inland parts of which this species inhabits, it is called the parson, and by some the bishop; and the Spaniards at Mexico, which country it inhabits, also name it azul lexos, or "far-fetched blue bird." It feeds on seeds, and is said to have the note of the common linnet.

**CYANELLA.** Shining blue-interfeathers and shoulders varied with blue and rufous; quill and tail-feathers edged with blueish. Sparrm. Mus. Carl. *Emberiza cyanella*, Gmel. *E. cyanea*,  $\beta$  Lath.

Described by Sparrman as a species. Gmelin admits it with doubt, and Latham considers it as a variety only of *cyanea*; it is a native of North America.

**QUELEA.** Grey; front black; bill scarlet. Gmel. *Moineau à bec rouge du Sénégal*, Buff. *Black faced bunting*, Lath.

The bill of this bird is thick; cheeks and chin black; rest of the head, shoulders, and back varied with black and grey; breast and belly reddish white; quill and tail-feathers blackish, edged with cinereous. The species inhabits Senegal, and is four inches and a half in length. The female resembles the male, but wants the black about the head. The bird described by Buffon, under the name of *Moineau du Senegal*, is considered as a variety.

**PETRIX.** Chestnut, beneath yellow; eye-brows and rump yellow; middle of the head and breast with a broad black band. Gmel. *Weaver bunting*, Lath.

Size of the house sparrow, which bird it resembles in the brownish colour of the plumage during winter. The name of weaver bunting was given to this bird from its propensity to interweave silk between the wires of its cage, like the weaver oriole, and, it is conjectured, the nest of the weaver bunting is composed in a manner somewhat similar to that of the above-mentioned oriole, which consists of leaves curiously sewed together with the filaments of plants. This bird inhabits Africa.

**RUBRA.** Crimson; neck and back varied with olive and black, and a few crimson marks; belly and vent cinereous; quill and tail feathers black, edged with grey-green. Gmel. *Moineau de l'île de France*, Buff. *Crimson bunting*, Lath.

Size of the last, and inhabits the île of France. The bill is black; legs pale flesh colour; female olive and paler beneath.

**CAPENSIS.** Grey; throat whitish; ocular band and another beneath blackish. *Hortulanus capitis lone sp. i.*, Buff. *Ortolan du Cap de Bonne Esperance*, Buff. *Cape bunting*, Lath.

Native of the Cape, and in size resembles the sparrow. Three varieties of this species are described in Buffon's

"Planches Enluminees," namely,  $\beta$ , the body of which is yellow beneath, and the sides of the head and neck marked with three black stripes;  $\gamma$ , having the body beneath whitish; and  $\delta$ , which is whitish beneath, and has the throat varied with cinereous. The two first of these are conceived to be merely varieties of the Cape kind, the last is a native of Cayenne, where, according to Buffon, it is called *Bonjour-commandeur*, from being accustomed to commence its song at the break of day.

**FUSCA.** Brownish; wings and tail brown with dusky bands; belly white; nostrils, cheeks, and chin with feathered tufts. Gmel. *Barred-tailed bunting*, Lath.

Described by Dr. Latham from a figure met with among some Chinese drawings. The size is said to be that of the common bunting. The beak is flesh-coloured; legs rosy.

**LUDOVICIA.** Rufous spotted with black; beneath pale; breast rufous; head with a black crescent. Gmel. *Hortulanus ludovicianus*, Briff. *Ortolan de la Louisiane*, Buff.

Length five inches and a quarter. The bill rufous spotted with black, head and throat reddish; rump and cuneated tail black; breast rufous; legs cinereous. Native of Louisiana.

**CIA.** Reddish; head with a few blackish lines; eye-brows white. *Emberiza barbata*, Scop. *Emberiza pratensis*, Gessn. *Bruant fou*, Buff. *Bruant de sprés*, Buff. *Foolish bunting*, Lath.

Native of the warmer parts of Europe, and delights most in mountainous situations; it is a silly bird, and easily caught in any snare, whence its name; its note is only a repetition of sounds, like the pronunciation of the words zi-zi-zi-zip-zip. The Genoese call it *Cia montanina*.

**CIRLUS.** Fuscous; breast spotted; eye-brows pale yellow; two outmost tail-feathers with a white cuneated spot. Gmel. *Emberiza sepiaria*, Briff. *Cirlus*, Aldr. *Cirl bunting*.

Size of the yellow-hammer, and inhabits Italy and France; the species has been lately found in Britain.

**FAMILIARIS.** Cinereous spotted with brown; tail-feathers white at the tip; hind part of the back yellow. Gmel. *Bruant familier*, Buff. *Familiar bunting*.

Osbeck describes this species under the name of *Motacilla familiaris*. This writer speaks of it as a docile bird, and says, if the cage-door was opened it would jump out upon the person's hand who released it, and if any one whistled in its hearing, it sang sweetly in return. If a dish of water was placed before it, the bird instantly plunged into it, and bathed itself. It was fed with rice.

**FLAVEOLA.** Grey; face yellow. Gmel. *Flaveole*, Buff. *Yellow-faced bunting*.

Native of warm climates, and very small.

**AMAZONIA.** Brown; crown fulvous; vent whitish. Gmel. *Amazone*, Buff. *Amazon bunting*.

Size of the titmouse, and inhabits Surinam.

**ORYZIVORA.** Black; crown reddish; belly black; tail-feather daggered. Gmel. *Agripenne ou Ortolan de riz*, Buff. *Rice bird*, Catesby. *Rice bunting*, Arct. Zool.

About the size of the sparrow. The species is confined to the continent of America, and is of the migratory kind, passing in flocks at particular seasons from one part to another. The Americans call it *Bob Lincoln* and *Conquedle*. Its food consists of grain and insects, and the maize especially; they are remarkably fond of this plant, and prove highly destructive to the crops, by unnecessarily perforating the husks after satisfying their appetites, and thus leaving openings

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openings through which the rain penetrates, and effectually destroys the plants. Some, for this reason, call it the maize thief, or white backed maize thief. Its note is much admired. There is a variety of this bird of an olive-brown colour, beneath y flowish; rump yellow, transversely lined with brown; greater wing-coverts and quill-feathers edged with white.

**SCHOENICULUS.** Head black; body grey and black; outmost tail-feathers with a white wedged spot. Linn Fn. Succ. *Junco turneri*, Geln. Buff. *Reed bunting*, Lath.

Native of Europe and the southern parts of Siberia. The female differs from the male in having the head brownish instead of black.

**LESBIA.** Beneath white; face white with three black bands; breast and rump brownish; tail-feathers white, the two middle ones dusky, edged with rufous. Gmel. *Mitilene de Provence*, Buff. *Lesbian bunting*, Buff.

Length about four inches and a half; it inhabits Provence, where it is called Chic de Mitilene, being rare in that part, and known to be common in the Greek isle Mitilene, or Lesbos. They are said to exert a peculiar kind of scream on the approach of any bird of prey, a circumstance which the Greeks turn to some advantage, for they place one or more of these birds inclosed in strong iron cages in their poultry yards, and the approach of the hawk, or any other bird of prey, is loudly announced by these little centinels the moment it appears in sight; and by this means the poultry are allowed sufficient time to effect their escape.

**PROVINCIALIS.** Beneath white; band across the eyes and on the wing and chin white; spot under the eyes, streak each side the chin, and breast brownish spotted with black; quill and tail-feathers dusky, edged with rufous. Gmel. *Gavoué de Provence*, Buff. *Mustachoe bunting*, Lath.

Size of the last, and inhabits Provence.

**LOTHARINGICA.** Spotted with black; above rufous, beneath cinereous, abdomen rufous; streak across the eyes and on the mandibles black; tail-feathers black and white, middle ones rufous; exterior ones nearly all white. Gmel. *Ortolan de Lorraine*, Buff. *Lorrain bunting*.

Inhabits Lorrain; the female is white beneath, and has a whitish spot above and a rufous one beneath the eyes. Length six inches and a half.

**PSITTACEA.** Brownish-ash; wings tawny; two tail-feathers very long. Gmel. *Fringilla brasiliensis*, Seba. *Veuve éteinte*, Buff. *Psittaceous bunting*, Lath.

Size of a sparrow, and inhabits Brasil.

**PARADISEA.** Black; breast red; four middle tail-feathers long, and pointed; two very long, bill black. Scop. *Vidua*, Briss. *Indian long-tailed sparrow*, Will. - *Red-breasted long-tailed finch*, Edw. *Whidah bird*, Lath.

Native of Angola in Africa.

**SERENA.** Head black; crown red; tail cuneated; two middle tail-feathers very long; legs grey. Gmel. *Vidua minor*, Briss. *Veuve dominicaine*, Buff. *Dominican bunting*, Lath.

Like the rest of the long-tailed buntings, this bird is destitute of the two long tail-feathers during winter, and changes its plumage twice in the year.

**VIDUA.** Blackish; beneath whitish; four middle tail-feathers long and pointed, two of them very long; bill red. Gmel. *Vidua major*, Briss. *Grande veuve*, Buff. *Long-tailed sparrow with a scarlet bill*, Will.

The body of this species is less than that of the sparrow; the species inhabits Angola in Africa and India.

**PRINCIPALIS.** Variegated; breast rufous; four middle tail-feathers very long; bill and legs red. Gmel. *Vidua angolensis*, Briss. *Variegated bunting*, Lath.

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Inhabits Angola.

**REGIA.** Middle tail-feathers very long, equal, feathered only at the tip; bill red. Gmel. *Veuve à quatre brins*, Buff. *Shaft-tailed bunting*, Lath.

Inhabits the maritime parts of Africa. Length four inches and a half. The body above and vent black; throat, temples, orbits, and body beneath rufous; legs red.

**LONGICAUDA.** Black; shoulders orange, edged with white; tail-feathers long, the six middle ones very long. Gmel. *Veuve à épaulettes*, Buff. *Yellow-shouldered oriole*, Brown.

Native of the Cape of Good Hope.

**PANAYENSIS.** Black; breast with a large scarlet spot; four middle tail-feathers very long, pendulous, pointed and equal. Gmel. *Veuve en feu*, Buff. *Veuve de l'isle de Panay*, Sonnerat. *Panayan bunting*.

Inhabits the isle of Panay.

**ANGOLENSIS.** Black; crown and collar yellow; tail long. Gmel. *Gros-bec à poitrine couleur de feu*, Salerne. *Angola bunting*.

Size of a finch, and inhabits Angola.

**CIRIS.** Head blue; abdomen fulvous; back green; feathers green brown. Gmel. *Painted finch*, Catesby. *China bulfinch*, Albiu. *Painted bunting*, Arct. Zool.

Length five inches and a half, varies in colour, and inhabits South America; they build in the orange trees, and feed on plants of various kinds. In Holland, and some other parts of Europe to which they have been transported, they are reared in cages like the Canary with us, and are said to live eight or ten years in this state of captivity.

**QUADRICOLOR.** Head and neck blue; back, wings, and tail at the tip green; tail and abdomen in the middle red; breast and remainder of the belly brownish. Gmel. *Gros-beak de Java*, Buff. *Red rump bunting*, Lath.

Native of Java. Length five inches.

**CYANOPIS.** Green; wing and abdomen rufous; front, cheeks and chin blue; quill-feathers brown, edged with green; tail-feathers edged with red; middle ones green, the rest brown. Gmel. *Chloris javensis*, Briss. *Toupet bleu*, Buff. *Blue faced bunting*, Lath.

Length four inches; inhabits same country as the last.

**VRIDIS.** Above green; beneath white; wings and tail blue. Gmel. *Chloris indica minor*, Briss. *Parement bleu*, Buff. *Green bunting*, Lath.

Size of a sparrow; the bill greenish brown; shafts of the quill and tail-feathers white; and legs black. Native of India.

**PLATENSIS.** Above greenish-brown; beneath whitish-ash; back varied with black; quill, and lateral tail-feathers edged with yellow. Gmel. *Emberise à cinq couleurs*, Buff. *Plata bunting*, Lath.

Length eight inches. This species inhabits near the river Plata in South America.

**BORBONICA.** Rufous red; wings, tail, and legs chestnut. Gmel. *Mordoré*, Buff. *Bruant de l'isle de Bourbon*, Buff. *Bourbon bunting*.

Inhabits the isle of Bourbon.

**CALFAT.** Hoary; beneath vinaceous; head, chin, and edge of the tail black; bill and orbits rosy. Gmel. *Calfat*, Buff. *Red-eyed bunting*, Lath.

Less than the common sparrow, and inhabits the isle of France.

**CHLOROCEPHALA.** Fuscous; head and neck olive; back and wing-coverts varied with brown and black; tail forked. Gmel. *Green-headed bunting*. Brown's illustr.

A very ambiguous kind; probably an accidental variety of some European bunting. The bird described was caught

in Mary-le-bone fields, and preserved in the Tunstall Collection.

**GRISEA.** Grey; wing-coverts and breast varied with red; quill and tail-feathers within white, without varied with grey and red. Gmel. *Emberiza Surinamensis*, Briss. *Gonambouch*, Seba. *Grey bunting*, Lath.

Inhabits Surinam, where it is common, and its note is said to be equal to that of the nightingale. Its food is chiefly maize. The natives call it gonambucho.

**SURINAMENSIS.** Grey, beneath pale-yellow; breast with oblong black spots. Gmel. *Prayer*, Fermin. *Surinam bunting*, Lath.

Rather larger than the lark. Inhabits Surinam.

**RUFICAPILLA.** Body above fuscous, beneath cinereous; chin ferruginous; frontlet white; above reddish; tail black. Sparm. Mus. Carl.

**ASIATICA.** Cinereous; wings and tail brown. Lath. Ind. Orn. *Gaur bunting*.

Inhabits the East Indies, where it is known by the name of gaur.

**EMBLEM**, *ἔμβλημα*, a kind of painted ænigma, which, representing some obvious history, with reflections underneath, instructs us in some moral truth, or other matter of knowledge.

The word is pure Greek, formed of the verb *εμβαλλειν*, to cast in, to insert. Suetonius relates, that Tiberius caused the word to be erased out of a decree of the Roman senate, because it was borrowed from another language.

Such is that very significant image of Scævola, holding his hand in the fire; with the words, "agere & pati fortia, Romanum est;" "to do and suffer courageously is Roman."

The emblem is somewhat plainer, and more obvious, than the *ænigma*; which see. Gale defines emblem an ingenious picture, representing one thing to the eye, and another to the understanding.

The Greeks also frequently gave the name emblems, *εμβληματα*, to inlaid or mosaic works, and even to all kinds of ornaments of vases, moveables, garments, &c. And the Latins used *emblemata* in the same sense. Accordingly, Cicero, reproaching Verres with the statues and fine wrought works he had plundered from the Sicilians, calls the ornaments fixed thereto (and which, on occasion, might be separated from them) *emblemata*. Add, that Latin authors frequently compare the figures and ornaments of discourse to these *emblemata*: thus, an ancient Latin poet, praising an orator, says, that all his words were ranged like the pieces in mosaics,

" Ut tessellæ omnes,  
Arte pavimenti, atque emblemate vermiculata."

We do not use the English word emblem in this sense; though the ancient juriconsulti always retain the Latin *emblemata* to express such ornaments; because the Greek *εμβλημα* literally denotes any thing applied, or added to a body by way of enrichment.

With us, emblem ordinarily signifies no more than a painting, basso relievo, or other representation, intended to hold forth some moral or political instruction.

What distinguishes an emblem from a device is, that the words of an emblem have a full, complete sense of themselves; nay, all the sense and signification which they have together with the figure. But there is yet a farther difference between emblem and device; for a device is a symbol appropriated to some particular person, or that expresses something which concerns him particularly; whereas an emblem is a symbol that regards all the world alike.

These differences will be more apparent from comparing the emblem above quoted with the device of a candle lighted; and the words, "juvando confumor," "I waste myself in doing good." See **DEVICE**.

According to lord Bacon, emblems are of use in the art of memory, as sensible objects strike the mind stronger than what is intellectual. Thus, it is easier to retain the image of a sportsman hunting a hare, of an apothecary ranging his boxes, an orator making a speech, a boy repeating verses, or a player acting his part, than the corresponding notions of invention, disposition, elocution, memory, and action. Works abr. vol. i. p. 136. vol. ii. p. 475. and vol. iii. p. 106.

**EMBLEMS, Hagiographical.** The statues and pictures of the apostles, martyrs, and other ancient saints, are distinguished by their respective emblems. These appear to have been fixed upon by the artists of the 12th and 13th centuries. Sometimes they represent the instruments of their death or torments, as the Burgundy cross of St. Andrew, the gridiron of St. Laurence, the cardine comb of St. Blase, the wheel of St. Catharine; at other-times they relate to some circumstances in the life or legend of the saint, as the organ of St. Cecily, the dove of St. Gregory the Great; frequently they bear allusion to the name of the holy personage, as the lamb of St. Agnes, the gigantic stature of St. Christopher, bearing the infant Christ upon his shoulders.

**EMBLEMATICAL CHARACTERS.** See **CHARACTER**.

**EMBLEMENTS, Fr. from *emblaver*, q. d. *semer en blé***, to sow with wheat, a term strictly signifying the profits of lands sown; though sometimes used more largely for any profits arising, and growing naturally from the ground; as grass, fruit, &c.

If a tenant for life sow the land, and die before harvest, his representatives shall have the emblements to compensate for the labour and expence of tilling, manuring, and sowing the lands, and also for the encouragement of husbandry; and not he in reversion. But if the tenant for years sow the land, and before severance the term expires, or the estate for life be determined by the tenant's own act, as by forfeiture for waste committed, or if a tenant during widowhood thinks proper to marry, there the lessor, or he in reversion, shall have the emblements, and not the lessee.

The advantages of emblements are particularly extended to the parochial clergy by 28 Hen. VIII. cap. 11.

All the cases of emblements turn upon the point of uncertainty; since the tenant could not possibly know when his landlord would determine his will, and therefore could make no provision against it; and having sown the land, which is for the good of the public, upon a reasonable presumption, the law will not suffer him to be a loser by it. But it is otherwise, and upon reason equally good, where the tenant himself determines the will; for in this case, the landlord shall have the profits of the land. (Co. Litt. 55, 56.) These emblements are distinct from the real estate in the land, and are subject to many, though not all, the incidents attending personal chattels. They were devisable by testament before the statute of wills (Perk. § 412.); and at the death of the owner, shall vest in his executor, and not his heir; they are forfeitable by outlawry in a personal action (Bro. Abr. tit. emblements, 21. 5 Rep. 116.); and by the statute 11 Geo. II. c. 19. though not by common law (1 Roll. Abr. 666.), they may be distrained for rent arrear. Although the emblements are assets in the hands of the executor, are forfeitable upon outlawry, and distrainable for rent, they are not in other respects considered

sidered as personal chattels; and particularly, they are not the object of larciny, before they are severed from the ground. (3 Inst. 109.)

**EMBLICA**, in *Botany*, Gærtn. t. 108. f. 2. See **PHYLLANTHUS** and **MYROBALANUS**.

**EMBODY**, in the *Military Art*. To *disembody*, relates to the separation of those individuals forming a regiment, &c. when its services are no longer required. This term is totally divested of that disgrace which is conveyed under the terms *dismissed*, or *broken*. Thus we find, that, during times of danger, the militia are called out; and on the return of peace, that orders are issued for their being "disembodied." Hence, in that admirable satire, "the Mayor of Garrat," major Sturgeon says, "Our corps is disembodied, so the French may sleep in security."

When a regiment is disembodied, or, in other words, disbanded, (though the latter term is often, but erroneously, intended to convey reproach,) the arms are lodged in the proper store-rooms; and every thing is numbered or ticketed; in order that when the regiment may again be called out, all may be in readiness for its equipment.

**EMBOLE**, in *Surgery*, the reduction or setting of a dislocated bone. The term is derived from the Greek *εμβολη*, to put in.

**EMBOLI**, in *Geography*, a town of European Turkey, in the province of Romania, a colony from Athens. It is called by the Christians "Christopolis," but is little better than a heap of ruins; 48 miles E. of Saloniki.

**EMBOLIMA**, in *Ancient Geography*, a town of India, on this side of the Ganges. It was situated S.W. of Petra Aornos, upon the right of the Indus, and N. of Taxila.

**EMBOLIMÆAN** and **EMBOLISMIC**, *Intercalary*, is chiefly used in speaking of the additional months which chronologists insert to form the lunar cycle of 19 years.

The 19 solar years, consisting of 6939 days, and 18 hours; and the 19 lunar years only making 6726 days; it was found necessary, in order to render the 19 lunar years equal to the 19 solar, which make the lunar cycle of 19 years, to intercalate or insert 7 lunar months, containing 209 days; which, with the 4 bissextile days happening in that interval, make 213 days, and the whole, 6939 days. See **CYCLE**.

By means of these seven embolismic, or additional months, the whole 6939 days and 18 hours of the solar years are employed in the calendar.

In the course of 19 years there are 228 common moons, and 7 embolismic moons. Their distribution is thus: every 3d, 6th, 9th, 11th, 14th, 17th, and 19th, years, are embolismic, and consequently contain 384 days a-piece. And this was the method of computing time among the Greeks, when they used the enneadæcteries, or cycle of 19 years. But they did not keep regularly to it, as the Jews seem to have done. The Greeks were followed by the Romans till the time of Julius Cæsar.

The embolismic months, like other lunar months, are sometimes 30 days, and sometimes only 29. See **YEAR**.

The embolismic epacts are those between XIX and XXIX; which are thus called, because, with the addition of the epact XI, they exceed the number XXX: or rather, because the years, which have these epacts, are embolismic; having 13 moons a-piece, whereof the 13th is the embolismic.

**EMBOLISMUS**, *εμβολισμος*, in *Chronology*, signifies intercalation.

The word is formed of *εμβαλλω*, to insert. See **EMBOLISMIC**.

As the Greeks made use of the lunar year, which is only

354 days, in order to bring it to the solar, which is 365 days, they had every two or three years an embolism, i. e. they added a thirteenth lunar month every two or three years; which additional month they called embolimus, *εμβολιμυς*, because inserted, or intercalated.

**EMBOLUS**, the immovable part of a pump, or syringe; called also the *pisson*, and popularly the *sucker*. See **PISTON**, **PUMP**, and **SYRINGE**.

The pipe, or barrel of a syringe, &c. being close shut, the embolus cannot be drawn up without a very considerable force; which force being removed, the embolus returns again with violence. This phenomenon the Aristotelians attribute to nature's abhorrence of a vacuum.

But the modern philosophers finding, that in an exhausted receiver the embolus is easily drawn up, though the orifice be stopped, prove that it is the pressure of the atmosphere on the external parts of the embolus, that makes the difficulty of drawing it up. See **AIR**, **ATMOSPHERE**, and **SUCTION**.

**EMBORDERED**, in *Heraldry*, a term applied to a border, when it is of the same metal, colour, or fur, with the arms.

**EMBORISMA**, an aneurism.

**EMBOSSING**, or **IMBOSSING**, the act of forming, or fashioning works in relief, whether they be cast, or moulded, or cut with the chissel, &c.

Embossing is one great part of sculpture; being that which has to do with figures raised, or prominent from the plain, or ground; the other part, which makes figures, &c. that are indented, or cut in below the ground, is called engraving. See **ENCHASING**.

**EMBOSSING**, or *Imbossing*, in *Architecture*, is that kind of sculpture wherein the figure is made to stand in relief beyond a plane or naked from which it seems to rise. It has three denominations, according to the degree with which it rises from the surface, as basso-relievo, mezo-relievo, alto-relievo; or low-relief, mean-relief, high-relief.

**EMBOTHRIUM**, in *Botany, so named by Forster from *ev*, *in*, and *βοθριον*, a little pit, or hollow, alluding to a small cavity towards the point of each petal, in which the almost sessile anthers are severally placed. Forst. Gen. 8. t. 8. Linn. fil. Suppl. 16. Schreb. 62. Willd. Sp. Pl. v. 1. 537. Juss. 79. Mart. Mill. Dict. v. 2. Sm. Bot. of N. Holl. 19—29. t. 7—10. Class and order, *Tetrandria Monogynia*. Nat. Ord. *Proteacea*.*

Gen. Ch. *Cal.* none. *Cor.* Petals four, cohering by their lower part into a tube, linear, oblique, at length revolute; their summits dilated, concave, bearing the stamens. *Stam.* Filaments four, very short, inserted into the hollow in the tip of each petal; anthers rather large, kidney, or heart-shaped. *Pist.* Germen superior, stalked, linear, ascending, inflexed; style incurved; stigma large, obtuse, lateral. *Per.* Follicle stalked, somewhat cylindrical. *Seeds* in two rows, imbricated, compressed, each with a membranous wing, generally numerous.

Ess. Ch. Petals four. Stamens inserted into the limb. Follicle containing several winged seeds.

This is a fine genus of the Proteaceous order, chiefly found in New Holland. One of the two original species, indeed, *E. coccineum*, Linn. Suppl. 128. Cav. Ic. v. 1. 47. t. 65, grows on the cold hills bordering the straits of Magellan, even in Terra del Fuego. Yet this appears by Commerson's and Forster's specimens to be a very handsome shrub, with all the air of a North American *Kalmia* or *Rhododendron*. The leaves are elliptical and entire, smooth, pale beneath. Flowers scarlet, in a dense terminal-cluster,

with small linear *bractæas*. *Follicle* short, and rather semi-ovate.

*E. speciosissimum*, Sm. Bot. of New Holland 19, t. 7, is a still finer species, a native of New South Wales, where the natives call it Waratâh. Living plants were sent many years ago to the dowager lady de Clifford. This is remarkable for the numerous large scarlet *bractæas*, which envelop its dense spike of the same colour. The *leaves* are obovate and serrated, remarkably obtuse.

*E. flajfolium*, Sm. Bot. of N. Holland, 23, t. 8. flowered at Mr. Grimwood's nursery, Kensington, in 1792, being forced in the stove. It comes also from New South Wales, and has finely divided rigid *leaves*, with loose spikes of white *flowers*.

*E. fericum*, *ibid.* 25, t. 9, and some of its varieties are now not rare in the greenhouses about London. See Curt. Mag. t. 862, and Andr. Repof. t. 100 and t. 272.

Mr. R. Brown, in paper on *Proteacea*, read last winter before the Linnæan Society, has new-modelled and greatly subdivided the genus *Embohrizium*, he having had opportunities of studying its species alive in their native situations, which no other botanist has so fully enjoyed.

EMBOUCHURE, a French term in *Music*, literally the hole in the upper joint of a German flute, in which the performer breathes; but when it is said that a flute player has a good embouchure, it means that his tone is good.

EMBOUL, in *Geography*, a town of Africa, in the country of Senegal.

EMBOWELLING ALIVE, in *Law*, is part of the punishment of high treason.

EMBRACE a VOLT, in the *Manege*, is used when a horse, in working upon volts, makes a good way every time with his fore legs. The opposite term to embracing a volt, is beating the dust, which is putting his fore-feet near the place from whence he lifted them.

Embracing the ground is used in the same sense with embracing the volt. A horse cannot take in too much ground provided his croupe does not throw out; that is, does not go out of the volt. See BEAT.

EMBRACEOR, in *Law*, a person who, when a matter is in trial between party and party, comes to the bar with one of the parties (having received some reward so to do), and speaks in the cause, or privately labours the jury, or stands there to overlook, awe, or put them in fear; or, who makes any attempt to influence a jury corruptly to one side by promises, persuasions, intreaties, money, entertainments, and the like. (1 Hawk. P. C. 259.) The punishment for the person embracing is by fine and imprisonment; and for the juror so embraced, if it be by taking money, the punishment is (by divers statutes of the reign of Edward III.) perpetual infamy, imprisonment for a year, and forfeiture of the tenfold value.

EMBACERY, the act or offence of embraceors. See EMBRACOR.

EMBRASURE, in *Architecture*, an enlargement of the gap or aperture of a door, or window, within-side the wall. See DOOR.

Its use is to give the greater play, for the opening of the door, wicket, casement, &c. or to take in the more light.

The embrasure coming sloping inwards, makes the inner angles obtuse. When the wall is very thick, they sometimes make embrasures on the outside.

EMBRASURE, in *Fortification*, is an opening made through the upper part of the defences, called the *parapet*, for the purpose of pointing the cannon, so as to be as little as possible exposed to the fire of the enemy. The embrasure must

vary in dimensions with the several sizes, or, as they are technically termed, the "natures" of the cannon to be employed in them respectively. It is, however, generally found, that about  $2\frac{1}{2}$  diameters of the muzzle of the cannon intended to be mounted give space enough for traversing, and at the same time afford but little opening for the shot from opposing batteries. The embrasure must be cut down in that proportion which may suit the height of the carriages on which the cannon may be mounted: thus, for all under 24 pounders, the height, between the front of the platform, and the crest, *i. e.* the interior, or highest part of the slope, over which the cannon is levelled, ought not to exceed 28 inches, unless the trucks on which the carriages run are unusually high; for all cannon of 24 pounds calibre, and upward, the space above described, and which is called the *genouillere*, ought to be from 34 to 40 inches. The best rule is, to allow eight inches between the crest of the slope and the under part of the cannon, when horizontally laid, thereby to command freedom of action, even when the depression of the line of fire may be considerable: were this not attended to, the cannon might, at such times, be levelled after each discharge, before it could be run up to the *genouillere*; whereby considerable delay would be created. The slope, by which we mean that part under the muzzle of the cannon, is ordinarily made with a descent of about ten or twelve degrees from the crest outwards, to allow of depression, so as to fire either into the ditch, or over the glacis; this slope must necessarily vary according to the situation, and intention of the battery. Thus, in some situations it is found necessary even to invert the slope, the cannon being always pointed above the horizon: this occasionally happens in erecting batteries while besieging a place, where it would be both useless and disadvantageous to cut the embrasures any lower than the lowest direction to which the cannon should be pointed. On the other hand, we sometimes see the slopes made at full forty degrees of depression, in consequence of the battery being intended to command some work, of approach, far below its own level. But, as before observed, when works are constructed upon an ordinary *defilement*, (or branching out,) originating from a level at the exterior of the *glacis*, and proceeding without any increase of elevation to the centre of the place, then from 10 to 12 degrees of depression in the slope will be fully adequate to all the purposes of depression of the cannon. The expansion of an embrasure, that is, its becoming wider exteriorly, than it is interiorly, must depend on circumstances; but we generally find their sides to diverge at an angle of about 12 or 15 degrees from a line passing through the centre of the slope, in a direction with the chace of the cannon when brought up square to the *genouillere*. It should, perhaps, seem proper to make the embrasure spread as widely as possible, for the purpose of including a greater extent of direction; but were such to be practised, the *merlon*, *i. e.* the body of parapet left between any two embrasures, would be so considerably diminished as to afford little protection from the enemy's shot, which would, at the same time, gain admission, obliquely, into the battery, and dismount the cannon by a plunging fire. On the other hand, it is absolutely necessary to give such an expansion as may not only allow the reasonable traversing of the cannon, thereby to cover a greater extent of the approaches, but to prevent the *merlons* from being destroyed by the fire of their own cannon, of which the explosion would speedily bring down the revetements, whether of masonry or of turf, unless ample space were allowed for the concussion of the air created by the discharge to be sufficiently weakened. We have heard of defences that were destroyed rather by the

want of this consideration, than from the enemy's fire. Where the *merlons* are of solid masonry, and consequently the thickness of the parapet inconsiderable, when compared with that attendant upon *merlons* made of soil, there may be allowed rather more contraction than in the latter case, because the explosion is not confined for such a distance. Few cases, however, can occur, in which the divergence of the sides can come under ten, or exceed fifteen degrees. Where it is not advisable to keep all the intended embrasures open, or where deception is an object, they are either left unfinished, the parapet being left entire, or their fronts are filled up with the same materials as the front of the parapet. The former is common in situations where the soil is loose, and the difficulty of sustaining the merlons considerable. When embrasures are cut through such parapets, their sides must be sustained by *fuscines*, as in the case of field batteries, and approaches during a siege. The latter description, *i.e.* the concealed embrasures, form what is called a masked battery, which generally opens by surprise; the first discharge generally serving to clear away the slight work built up for the purpose of concealing the situations of the cannon. Where it is absolutely necessary that cannon should be allowed to traverse freely in various directions, such, for instance, as sea-lines, where every gun should be made to follow a ship passing with a rapid tide, and likewise in block-houses mounting heavy ordnance on their roofs, no embrasures should be made; but the cannon should be mounted on carriages traversing on pivots, and elevated above the body of the ramparts, which may nevertheless be made high enough to cover the defenders very completely. Cannon mounted in this manner command a great range of direction, and, though not so well secured from being dismounted as when placed in embrasures, are pre-eminently serviceable in some situations. Batteries of this description are called *barbet batteries*, and should, with little exception, be invariably preferred, wherever they are not liable to be opposed by cannon, or where the force to be acted upon is expected to pass with velocity, without being able to take a settled aim at the *barbet*. Mortar batteries have no embrasures, they requiring only a given line of direction, aided by due elevation, to effect their object; and, as both may be given without seeing it, the parapets of such batteries are left entire. What are called embrasures on board bomb-ketches, are nothing more than temporary openings made by unshipping hatches, and by fitting stout planks at the sides to confine the sparks from spreading within the vessel. In casemates, especially those in the *curtain*, &c. the embrasures are made like the port-holes in a ship; that is, nearly square, and allowing the muzzles of the cannon to pass completely through.

**EMBREGMA**, an embrocation. The term is derived from *εμβρεχω*, to make wet.

**EMBROCATION**, or rather **EMBROCHATION**, *Embrocha*, *Εμβροχη*, formed from *βρεχω*, *irrigo*, I sprinkle, or moisten, in Pharmacy, denotes the application of remedies, as oils, spirits, decoctions, and other liquids, by sprinkling, or even rubbing them on the part affected: this is also called irrigation.

Embrocations are only a kind of lotions; they are used to remove obstructions, and to relieve pains, numbness, and palsies. The pumping used in natural baths is properly an embrocation.

**EMBROCATION**, *gall*. See **GALL**.

**EMBROIDERY**, the enriching of a cloth, stuff, or muslin, by working diverse figures thereon with the needle, and thread of gold or silver.

The word embroidery is derived from the French

*broderie*, of *broder*, to embroider; which some deduce, by transposition, from *bordeur*, because they formerly embroidered only the borders of stuffs, whence the Latins also call the embroiderers *limbularii*. Du-Cange observes, that they anciently wrote *aurobrustus* for embroidered with gold, or *brustus brudatus*, and *brodatus*; whence *broderie*.

That done with silk, flax, or the like, is not now called embroidery; though anciently, and properly, the word denoted all kind of figuring or flourishing.

The chief use of embroidery is in church vestments, cloaths, housings, guidons, standards, &c. The invention of embroidery is attributed to the Phrygians; whence the Latins call embroidered garments "*vestes Phrygionia*," and embroiderers *Phrygiones*. In the "*Menæchmi*" of Plautus, (act ii. scene 3), a young woman, desirous of sending her mantle to be embroidered, says: "*Pallam illam ad phrygionem ut deferas, ut reconcinatur atque ut opera addatur, quæ volo.*" The Greeks seem to have used the words *αεβισυ* and *αοβισυ*, as we use the word embroider.

The embroidery of stuffs is performed in a kind of loom; that of muslin is done by stretching it on a pattern already designed; the former kind is the most easy, but the latter admits of the greatest richness and variety. The thinnest muslins are the best for this purpose; and they are embroidered to great perfection in Saxony.

There are diverse kinds of embroidery; as *embroidery on both sides*, that which appears on both sides. *Guimped embroidery*, performed either in gold or silver. In this work, a sketch is first made on the cloth, then they put on a cut vellum, and afterwards sew on the gold and silver with silk thread, interspersing silver and gold cord, tinsel, and spangles. *Embroidery on the stamp*, where the figures are very high and prominent, being supported on wool, cotton, hair, &c. *Low and plain embroidery*, where the figures are low and flat, and without any enrichment between them. It is probable that the covering of the sword of Goliath, which was laid up in the tabernacle as a consecrated memorial of the victory gained by David over that vain-glorious idolater, or the wrapper that enveloped it, was some beautiful piece of embroidered work. (1 Sam. xxi. 9.) By statute 22 Geo. II. c. 36. no foreign embroidery, or gold or silver brocade, shall be imported, upon pain of being forfeited and burnt, and penalty of 100*l.* for each piece. No person shall sell or expose to sale any foreign embroidery, gold or silver thread, lace, fringe, brocade, or make up the same into any garment, upon pain of having it forfeited and burnt, and penalty of 100*l.* All such embroidery, &c. found, may be seized and burnt, and the mercer, &c. in whose custody it was found shall forfeit 100*l.*

**EMBRUN**, or **AMBRUN**, in *Geography*, a town of France, in the department of the Upper Alps; chief place of a district of the same name, situated upon a high rock on the right shore of the river Durance, 66 miles S.W. of Grenoble, and 480 miles S. by E. of Paris, is chiefly remarkable for its cathedral, and has a population of 3138 individuals. The canton contains 8 communes and 9667 inhabitants, on a territorial extent of 285 kilometres.

As chief place of a district Embrun has a sub-prefect, two courts of justice, and a register office. The whole district is extremely mountainous, but the vallies and the declivities of the mountains are uncommonly fertile. It contains five cantons, 36 communes, and 26,968 inhabitants, on a territorial extent of 1472½ kilometres.

**EMBRYO**, or **EMBRYON**, in *Anatomy* and *Physiology*, is the child, with its coverings, as contained in the uterus previously to the time of birth. It is supposed at first to be in an imperfect state, but to contain rudiments of all the parts,

parts, which, when fully developed, make up a perfect animal. The term is derived from the Greek word *ἐμβρυον*, which has the same signification, and is formed from *ἐν, in*, and *έρω, I shoot out*; conveying a notion, that the living germ buds forth and expands in the uterus of the mother, as a seed is developed in the earth. The term embryo is employed, in its most strict acceptation, during the first six weeks only after conception, but it is often used more generally during the whole time of utero gestation. The young animal, after the first six weeks, is called a *fœtus*; but we use this word also to denote the same object as soon as it can be distinctly perceived. By the *ovum*, we understand the *fœtus*, together with its surrounding membranes; but that term is sometimes applied to the latter only, in contradistinction to the former. We shall consider, under the present article, the progress of the uterine contents, until the time of utero-gestation is completed; the changes, which they pass through, in the different stages of this period; the peculiarities of structure belonging to the *fœtus*; and the mode of its nutrition and existence.

A sketch of the progress of the germ, after impregnation, from the ovarium into the uterus, and of its development in the latter cavity, will be found in the article CONCEPTION; a more detailed history of the anatomy of the ovary and uterus, together with a statement of all the facts that can be ascertained concerning the mode of impregnation, and its immediate consequences, will be contained under the head of GENERATION.

When the germ is detached from the ovarium, the mode of its existence differs in the different classes of the animal kingdom. In the greatest number of instances it is accompanied by an organized mass, to which it adheres by means of vessels, and the absorption of which is sufficient to nourish and develop it, until it is brought forth into the world. It requires no supply therefore from the body of the mother; and is even separated from her by more or less numerous and solid coverings. The germ, together with the nutritious substance, and the common envelopes, constitute an *egg*, and the animals which propagate their species in this way, are called *oviparous*. In many of these, the germ contained in the egg is not developed and hatched, until the egg has quitted the body of the mother, or has been *laid*; in which case fecundation may be performed afterwards, as in many fishes, or external heat only may be required, as in the incubation of birds: or, lastly, the natural temperature of the climate may suffice, as in reptiles and insects. All these are *oviparous* animals, properly so called. In some others, the egg, after having been fecundated, and detached from the ovary, remains in the mother's body, until the young one is developed and hatched, as in the viper, and in several fishes: such are falsely *viviparous*, or *ovo-viviparous* animals. Mammalia only are truly *viviparous*; their germ is provided with no supply of aliment, but derives the materials of its growth from the juices of the mother. For this purpose it is attached to the internal surface of the uterus, and occasionally, by accident, to some other part, by a kind of root; by an infinite ramification of blood-vessels, constituting the *placenta*. Instead, therefore, of being separated by its coverings from the body of the mother, these are the medium of a most intimate connection between them, essentially necessary to the life of the germ. Through them there is a constant influx of nutritious juices until the embryo is completely developed. At that time the membranes are torn, and the young animal comes into the world, capable of enjoying an independent organic existence, and free from all external covering. The very rare occurrence, of the child being born with its membranes

entire, cannot be regarded as an exception to this assertion: Wrisberg only saw it three times in 2000 births; (see his *Observat. de Structurâ ovi*, p. 76.) and it is probably still less common on the average. In the mammalia then there is no *egg*, in the sense already explained: the membranes of their *ovum* being an intimate connection between the mother and the germ, by which the former supplies the latter with nourishment; while the *egg* is entirely detached, and contains, with the germ, the nourishment necessary for its growth. Hence we see, that the old and much-contested maxim of "omnia ab ovo," cannot be received without great limitation, and is more likely to perplex, by confounding together things essentially different, than to impart any additional light to a subject already very obscure.

The following parts, which are of course contained in the cavity of the pregnant uterus, make up the human *ovum*; viz. the *placenta*, *membranes*, *navel-string*, *liquor amnii*, and *fœtus*. The three first are called also the *secundines* or *after-birth*; as they are expelled, in the act of parturition, after the child. The *placenta* and *membranes* every where line the cavity of the uterus, and the former must undoubtedly have some communication with the vessels of the mother, although anatomists have not yet succeeded in demonstrating the precise mode of that connection. In the membranous bag formed by the *secundines*, there is found, besides the *fœtus*, a greater or smaller quantity of clear fluid, called the *liquor amnii*. The umbilical chord contains blood-vessels, by which the circulating organs of the *fœtus* communicate with the arteries and veins of the *placenta*.

The *secundines* are all more or less gelatinous and transparent, and contain no manifest fibrous structure. Being destroyed after every pregnancy, their existence is temporary; and their organization corresponds to this limited term of duration. They never contain any fat, either in the sound, or in the morbid state of parts, at any period of utero-gestation, however the mother or child may be circumstanced in this respect.

The cavity of the uterus, examined immediately after conception, exhibits nothing which can be regarded as the fruits of that process. In a few days, we perceive a transparent membranous vesicle, filled with a gelatinous liquor, but offering no appearance of organization or life. Some writers have asserted that ova may be found in the uterus of the human subject, or of animals, immediately after conception; and have even published delineations of them in the first days of pregnancy. Such statements deserve no credit. Those modern physiologists, in whom we can place the greatest confidence, have found, during the first seventeen days, nothing but a fluid like white of egg, in which there was no trace of any more consistent body. Mr. Cruikshank, however, has met with ova in the tubes and uteri of rabbits, at a much earlier period. He found them in the former situation on the third day after coition: they were mere points, but the distinction of the chorion and amnios could be discerned by the aid of magnifying powers. The *fœtus* was rendered visible on the eighth day, by pouring vinegar on the *ovum*. We may regard all observations in which an *ovum* is said to have been discovered in the human subject, earlier than the twentieth day, as extremely suspicious: indeed, we know of no instance, in which it has been observed, before this time, by any person whose testimony has sufficient authority. A round little body is gradually developed in the cavity of the uterus, and may be recognized at the end of the third week. This is the covering of the future, but not yet discernible *fœtus*. The surface of such an *ovum* is probably flocculent from the first; this at least is the case in the smallest hitherto delineated,

delineated, and in well preserved specimens of very small and early abortions. The flocculi are very fine vascular ramifications, connecting the ovum to the decidua, which resembles in appearance a layer of coagulable lymph produced by inflammation. The resemblance of these villi to the roots of a plant, the mode of their insertion in the decidua, and the analogy of their function, in draining from the uterus and conveying to the child, the materials of its support, to the office which roots perform, in extracting nourishment from the soil, has led almost every writer to compare the rudiment of the future animal to a seed, and to consider its connection with the mother's body as similar to that between a plant and the earth. The vascular processes are small in very young ova, but enlarge afterwards rapidly till the second month: they gradually disappear from two-thirds of the surface of the ovum, and are collected together on the remainder, to be united into a mass, and form the placenta.

It has not been hitherto determined at what period the ovum becomes connected to the uterus; indeed it is so small, at its first arrival in the cavity, that the investigation is difficult. Cruikshank says, that the ovum increases in the rabbit, to one hundred times its original size, before it becomes fixed to the uterus. The size of the ovum, at different periods of pregnancy, cannot be determined with much accuracy, because many abortions are not well formed, and their exact age cannot be well ascertained. Hence different writers contradict each other considerably in this point. Within the first month it is not larger than a hazel nut; in the second and third it may equal a pigeon's or hen's egg. At the latter period its development is complete, and the future changes are chiefly in size. It increases in proportion to the augmentation of the uterus.

*Particular description of the component parts of the ovum.*—The membranous covering including the fœtus, within the uterus, consists of several distinct parts, which admit easily of artificial separation. The number of these has been very variously represented. The older anatomists only describe two; *viz.*, the chorion and amnios; and divide the former into two laminæ. Most moderns describe three coverings, adding the decidua of Hunter to the two former. Haller mentions four;—the *membrana exterior ovi*, chorion, *membrana media*, and amnios. Blumenbach's division into the proper, and adventitious coverings is a good one: the latter are the chorion and amnios; the former, the decidua, which covers the ovum and lines the uterus.

The *decidua*, or *membrana caduca*, is the medium of connection between the embryo and the mother. In its appearance, as well as in its mode of formation, it resembles the lamina of coagulating lymph, which is formed by inflamed surfaces. Both membranes are of a yellowish white colour; both are tender, pulpy, and vascular. The lamina of lymph is formed by an inflamed membrane; the uterus, before the appearance of the decidua, becomes much more vascular, and is probably in a state of increased action analogous to inflammation. The development of this membrane is probably anterior to the arrival of the germ in the uterus, and may be regarded as a measure of preparation for its reception. It is not necessary for the formation of the decidua, that the ovum should reach the uterus. For when it grows in the ovary, or in the Fallopian tube, the decidua is formed in the uterus, and that organ is considerably enlarged; so that it undergoes, to a certain degree, changes exactly similar to those which take place in natural pregnancy. It lines the whole internal surface of the uterus, being perforated at the Fallopian tubes, and cervix uteri. Numerous small arteries and veins, often seen containing red blood, ramify from its outer surface inwards

through its substance, and are derived from the vessels of the uterus. It is very thin, and has no perceptible vessels near the cervix uteri; but grows thicker and more vascular towards the placenta, at the very edge of which it acquires a considerable thickness, and splitting into two strata, is continued over both surfaces of the placenta, but especially the inner smooth surface, blending itself there inseparably with the umbilical portion of the placenta. The layer of the decidua, which lies between the chorion and placenta, is in one case much thicker than in another. It sometimes forms a smooth, tender, opaque membrane; but is more frequently reticulated, especially towards the edge of the placenta, looking somewhat like lace. Occasionally there are portions of it a good deal thicker than the rest; which, shining through the transparent chorion, bear some resemblance to pieces of fat. This layer is generally thicker than that which adheres to the rough, external, lobulated surface of the placenta. It communicates with that other, by means of the processes of the decidua, which pass between the lobules of the placenta, and along the external surface of the umbilical vessels.

We have already observed, that the decidua adheres closely, on its external surface, to the uterus, and that this adhesion is effected by means of blood-vessels passing to the former from the latter. By its means the whole external surface of the ovum grows to the uterus. Its internal surface is very closely attached to the chorion, so that their separation is difficult in recent secundines. Gentle putrefaction makes them part easily; and we observe, on the separation, numerous white slender threads, emerging from the substance of the chorion, and ramifying into smaller filaments upon the decidua. These appear like vessels by the aid of a magnifying glass.

As this membrane is an adventitious production of the internal surface of the uterus, formed for the temporary purpose of a connecting medium between the mother and the child; its office ceases as soon as the fœtus has quitted its original situation; and it is consequently shed whenever a woman bears a child, or suffers a miscarriage. Hence its names of *decidua* and *caduca*. As it may be partially separated into two strata, one of these is left on the uterus after delivery, and afterwards dissolves, and comes away with the lochia. Frequently a thicker stratum separates from the uterus in one part, and a thinner in another. The adhesion of the decidua to the uterus and chorion is stronger than that of the two layers of the membrane to each other; and hence, probably, we may explain the circumstance of a stratum being left upon the uterus after parturition. The best method of seeing the decidua after labour, is to wash the secundines well in warm water, to remove the loose coagulated blood, and then put them into cold water, that the blood, which remains in the vessels, may congeal. The decidua will then be very distinguishable by its yellowish appearance and pulpy consistence; and numerous vessels may be clearly discerned in its substance. The number and size of the vessels, passing from the uterus to the decidua, sufficiently account for the bleeding which always takes place on the separation. These vessels are represented as filled with blood in Hunter's 29th plate, fig. 4: and in their injected state in several other figures of the same work; *viz.* the arteries in fig. 3, tab. 24; the veins in tab. 24, fig. 4: and both kinds of vessels coming from the uterus, in tab. 31. The second fig. of tab. 29. of the same work, exhibits the reticulated lace-like appearance of the membrane, when viewed with magnifying powers: in this respect it much resembles the adventitious productions of coagulating lymph.

The preceding description applies to the decidua, as it is found

found in ova of seven, eight, or nine months. The membrane is very different in the earlier periods; and as the descriptions of anatomists have been derived chiefly from abortions, in which more or less of the decidua may come away with the ovum, and as the appearance of the membrane differs very much in the different periods, the accounts of it are very perplexed, and difficult to understand. The thickness of the membrane is in an inverse ratio to the age of the embryo. In an early state, too, its external surface is covered with numerous loose and floating flocculi, by which it adheres to the surface of the uterus; these are not seen at more advanced periods: they are excellently represented in an abortion of the seventh week, in two beautiful figures, forming the vignette of the title page of Soemmerring's *Icones Embryonum Humanorum*: also in Hunter, figs. 1, and 2. pl. 33.

From the time that the ovum has acquired some size, until about the fourth month, the decidua not only lines the whole cavity of the uterus, but also gives another covering to that part of the chorion, which is not occupied by the placenta. This second investment is continuous with the former at the edge of the placenta; and, as it appears at this part as if reflected from the exterior layer over the ovum, Dr. Hunter, to whom we are indebted for the most accurate observations on the whole subject, called it *decidua reflexa*; the addition of Hunter is often made by foreign anatomists. He compares, in the explanation of pl. 33, fig. 1, the reflection of the decidua over the ovum, to that of the pericardium over the heart; and the comparison might be correct, if the exterior portion of the pericardium covered the whole of the heart, as the outer layer of decidua does the whole ovum. According, then, to the preceding description, we may distinguish three portions of decidua, all, however, completely connected together; 1st. The exterior portion, covering the whole ovum, and lining the whole uterus, excepting the apertures corresponding to the Fallopian tubes and cervix; *decidua uteri*, *d. vera*, *membrana ovi exterior* of Haller, *membrana caduca crassa* of Mayer (Beschreib. des menschlichen Körpers, v. 5. s. 272.) because it is thicker than the reflected portion, first membrane of the ovum of Mekel, *decidua externa* of Sandifort, and external lamella of the Hunterian decidua of some authors. 2dly. A production over the concave surface of the placenta. 3dly. *D. reflexa*, covering the chorion, and continuous at the margin of the placenta, with the *D. uteri*. This is Blumenbach's acquired membrane, Mekel's second membrane, *villosa membrana placentæ*, *involucrum membranaceum* of Albinus, *membrana filamentosa* of Wrisberg and Roderer, chorion of Haller, chorion fungosum, flocculentum, &c., spongy chorion, reflected vascular membrane, &c. Denman calls it connecting membrane, and Baillie *decidua chorii*. A cavity must necessarily be intercepted between this and the *d. uteri*. The distinction of these two parts, and their relative position, are best seen in the plates of Hunter; as in fig. 1, of tab. 28: also in a perpendicular section of the uterus, containing an ovum of three months, represented in tab. 32, where the letters *k, l, m, n, o*, represent the two deciduæ, the angle of reflection, and the cavity left between them. The same facts are also represented in two abortions, figs. 1, 2, 3, and 4, of tab. 33. The *d. reflexa* covers the shaggy vessels of the chorion, which seem to be implanted in it. In proportion as pregnancy advances, it becomes gradually thinner and thinner, so that at the fourth month it forms an extremely fine layer covering the chorion. It comes at the same time into more close contact with the *d. uteri*, and, at length, the two adhere together. Yet the membrane

diminishes in thickness, and continues to decrease until parturition. How it comes to pass, that the decidua should envelope the ovum in the way already described, is mere matter of supposition, and does not admit of being shewn by direct demonstration. In two examinations, mentioned by Dr. Baillie as having been performed with great care at an early period of pregnancy, the decidua was already formed, but no ovum could be discovered.

In the 18th fig. of his work already quoted, Soemmerring has given an excellent view of the external surface of an ovum of five months. It appears on close inspection covered with fine and thinly scattered flocculi, which are the most numerous and long in the situation of the placenta. The first, or external coat, (the decidua,) is continued into the placenta, or the placenta is extenuated into this membrane, in such a way, that we might, with equal propriety, either regard the placenta as the thickest portion of the decidua, or the decidua as an extenuated production from the placenta. The decidua grows gradually thinner as we recede from the placenta, so that its thinnest portion is precisely opposite to the placenta.

The *chorion* is that covering of the ovum which is placed next in order to the decidua. It is the first proper membrane of Blumenbach, the third membrane of Mekel, and the second of many anatomists; the *membrana media* of Haller, chorion pellucidum or leve.

It is a firm and strong membrane, forming a complete bag, which includes the amnios and child. It adheres firmly to the concave surface of the placenta, and in that situation is thicker, and covers the great divisions of the umbilical vessels; being closely attached to the amnios at the insertion of the umbilical chord. At first it is nearly transparent, and tender in its texture: as the ovum increases, it becomes more opaque, stronger, and of a yellowish colour. We have mentioned already how its external surface adheres to the decidua, and the threads connecting them together, which seem to be vessels. These are the only vessels which the membrane possesses.

The external surface of the chorion is covered completely with flocculi in the first month of pregnancy. A great abundance of thin tender threads of different thickness arise from it. These divide and subdivide in a very minute manner, and the neighbouring ramifications join each other. They are extremely small on very young ova; but they cover the whole surface at the end of the first, and in the second month. They disappear from some parts in the third month; and collect closer together towards the upper part of the ovum, in order to form the placenta.

The decidua reflexa, covering this external surface of the chorion, unites the flocculi together; which penetrate it, and are implanted in the decidua uteri. Many erroneous names and representations have arisen from this structure, because the processes of the chorion have been regarded as belonging to the *d. reflexa*; and hence many of the names applied to that membrane have arisen.

In the fourth, fifth, and sixth months the chorion is smooth on the greatest part of its external surface. The *d. reflexa*, which is now thin and scarcely recognizable, is close upon it. When the placenta is formed, the external surface of the chorion is firmly attached to its concavity.

The internal surface of the chorion is smooth, and united to the amnios: In the first month there is a considerable interval between the two membranes, filled with a clear aqueous fluid, probably produced by the vessels of the chorion: this space is soon diminished; the amnios growing faster than the chorion, the two membranes soon come in contact.

contact. In the third month they lie near together, and are loosely connected by a tender gelatinous medium.

Twins have a double chorion, as well as amnios; but are covered by a common decidua reflexa.

*Amnios*; the second proper membrane of Blumenbach; and fourth membrane of Haller and Meckel; is found universally in animals. In man it forms an oval bag, including a certain portion of fluid, and the fœtus. It is a thin transparent membrane, of tolerably firm consistence. Its external surface is connected, in the way already described, with the chorion, from which it is easily separable. It lines the concave surface of the placenta, and terminates, apparently, by a close adhesion at the insertion of the navel-string, where the chorion also seems to end. The gelatinous substance connecting the two membranes adheres more closely to the amnios than to the chorion, and hence the former membrane has a rough appearance, when separated. The internal surface is every where perfectly smooth. In birds and quadrupeds it possesses manifest vessels; but none in the human subject.

The allantois, which was formerly enumerated among the membranes of the human ovum, is now known to be peculiar to quadrupeds.

There is, however, a small membranous bag, named *vesicula umbilicalis*, found in the early months of pregnancy between the amnios and chorion. This possesses an elliptical figure, and contains a clear fluid. It contracts into a thin and round thread, which runs along the navel-string, and divides into two at the insertion of the umbilical chord in the child's body. They are afterwards lost upon the viscera. This vesicula can only be seen until the third month, and in very fresh abortions; for it is so delicate that it decays very quickly; and it is extremely difficult to trace the thread from it through the umbilical chord. Its size is in an inverse ratio to the age of the embryo.

*Liquor amnii* is the name given to the fluid which fills the cavity of that membrane. This is perceivable as soon as the ovum can be discerned; it distends the membranes, and preserves their rounded form. Its quantity is the largest, in proportion to the size of the embryo, in the first month of pregnancy; so that in the first and second it considerably exceeds the weight of the fœtus, which must consequently be loosely suspended in the fluid. The fœtus weighs more in the third month than the liquor amnii; and, as it touches the membranes in the fifth, the proportional quantity of the water has very greatly decreased; so that it merely filled up the intervals caused by the inequalities of the child's body. Stein, an experienced German writer, states that the weight of the fœtus and the amniotic fluid should be equal about the middle of pregnancy; and that it must be regarded as an unnatural appearance, if the latter exceeds the former in the sixth month. It continues afterwards constantly decreasing relatively to the increase of the child. The quantity varies greatly in different subjects; from one to two pounds is the ordinary proportion at the period of nine months; but it may be much more or less. It is a clear yellowish fluid; but sometimes differently coloured and obscure. In its pure state it possesses no smell, and a mild saltish taste. Heat and alcohol coagulate it in the recent state; but the chief bulk of it is aqueous. The sources of the secretion are unknown. The absurd opinions, by which it has been supposed to proceed from the skin or various other parts of the fœtus, are sufficiently refuted by the fact of its existence when there is no fœtus. The amnios possesses no apparent vessels. For an account of the chemical properties of this fluid, see the article AMNIOS.

The old opinion of the use of the amniotic fluid in nourish-

ing the fœtus cannot be sustained; for deglutition could not be performed without the presence of air; many fœtuses are born with the mouth closely shut, and others have grown to the full size without any mouth at all. The great use of the fluid seems to be that of protecting the fœtus from external violence; and hence we find it most copious when the child is youngest and most delicate in texture, to prevent its different parts from adhering together, or to the surrounding membranes. The business of parturition, as far at least as the dilatation of the os uteri is concerned, is also facilitated by the liquor amnii.

The *umbilical chord, funis or funiculus umbilicalis*, or navel-string, made up of three large vessels twisted together, united by more or less gelatinous substance, and constituting, in consequence of certain convolutions of the vessels, an irregular rope, rather less in general than the size of the little finger, is fixed at one end to the child's navel, and at the other to the placenta. This being the organ of communication, through which the materials of growth and nourishment are derived to the fœtus from the mother, constitutes a most essential part of the secundines, and can never be deficient. It passes through the liquor amnii, from the child to the rest of the secundines; is commonly about two feet long, but may be no more than one foot, or on the contrary exceed four feet. Wrisberg once saw it only seven inches long; and it was necessary to cut it in the course of the delivery. Its most frequent length is between 18 and 22 inches. The younger the fœtus, the shorter is the chord proportionally. It is also thicker relatively to the size of the fœtus, as that is younger. It is usually turned round some part of the child's body; very commonly round the neck, which it has been seen to encircle four times and a half.

From the important function performed by the navel-string, we shall expect to find it as soon as the embryo itself is perceptible; and consequently it is seen as soon as the fœtus itself is visible.

The vessels of the chord are two umbilical arteries, and one umbilical vein. The two arteries are of equal size, and possess strong coats, so that their section presents a circular area. In rare instances there is only one. The umbilical arteries are a continuation of the internal iliacs; which, instead of descending into the pelvis, ascend along the side of the bladder to the umbilicus. When there is only one umbilical artery, the internal iliac of one side only is reflected along the bladder. The internal iliac, which in the adult is no larger, but rather smaller than the external, is considerably the largest of the two in the fœtus. It passes obliquely from the side of the pelvis to that of the bladder, and takes the name of umbilical or hypogastric; crossing the ureter in such a manner that that tube lies internally, and the artery externally. It ascends along the side to the fundus of the bladder, and proceeds over the surface of the peritoneum, to the umbilicus. These vessels make very numerous convolutions and turnings which differ considerably in different subjects; and hence they are much longer than the length of the chord. In the situation of these turns, the diameter of the vessels will appear contracted, and these contractions are the *quasi-valvule* of Hoboken.

The third vessel of the chord is the umbilical vein, which arises from the placenta, forms numerous convolutions, in company with the arteries, and enters the child's body at the umbilicus. Passing over the surface of the peritoneum, it arrives at the suspensory ligament of the liver; descends along its anterior margin to the fossa, dividing the two lobes; and there enters the substance of the liver. It distributes several branches to this viscus, particularly to its

left lobe, and ends by an anastomosis of its trunk, with the left branch of the vena portarum. From the vessel formed by this union a small canal, about three quarters of an inch in length, is continued into the inferior vena cava, under the name of *ductus venosus*.

The umbilical vein is much larger than the artery, and its sides collapse when divided. It is said that two veins have been seen; but Dr. Hunter never met with a case; quadrupeds have two. The umbilical vessels give off no visible branches till they come to the placenta; then the two arteries anastomose, commonly by a cross canal, nearly of the size of one of the arteries.

"There is a great variety," says Dr. Hunter, "in the twisting of the vessels of the navel-string. Sometimes they are uniformly and closely twisted like a rope, in their whole course; and sometimes they run almost straight and parallel, especially in that part of the string which is towards the placenta; for near the fœtus it is almost always more or less twisted. In some navel-strings there is a great irregularity, from solitary turnings of particular vessels, commonly called knots, as we see in twisting a cord, where some of the constituent threads are longer and therefore looser than others. The end of the navel-string which is next the placenta, is always less twisted, and more uniform than the end which is next the fœtus.

"Whatever be the cause, in most which I have attended to, the twisting of the navel-string has been in the same direction, *viz.* such as would be produced in turning the child round upon the navel, as a centre, by pushing its head towards the right side, and its feet to the left. In two and thirty preparations now before me, four only are twisted the contrary way; and of the twenty-eight which are twisted in the common way, three have the contrary twist for some inches, at the extremity, which was towards the fœtus." The vessels appear to be straight in young embryos. When the chord is very long, true knots are formed in it; as distinguished from those which arise merely from projections of particular vessels. These are not supposed in general to affect the communication between the mother and child, but Dr. Hunter thinks he has seen two cases in which it was obstructed from this cause. The true knots are sometimes double, as if twice tied; and in very rare cases treble.

The *urachus* is another part belonging to the umbilical chord; it is a small fibrous string ascending from the fundus of the bladder to the navel, between the umbilical arteries, and growing more slender as it proceeds. In the navel-string it is hardly perceptible, except near the fœtus; it is like a fine thread, a little more white and opaque than the rest. When once found near the fœtus, it may be traced, with a little trouble, nearly the whole length of the string. This part is a canal in the embryo of animals, leading from the bladder to the allantois; but the latter membrane not existing in the human subject, the urachus is solid. Portal, who has investigated the matter very attentively, found the urachus to consist of four threads in embryos of five and six months. These pass together from the navel to the bladder; then separate and expand over the latter organ. In the eighth and ninth month, these threads can hardly be separated. The urachus altogether is largest in the youngest embryos.

The covering of the navel-string, which is smooth and polished, is considered to arise from a reflection of the amnios. Both that membrane and the chorion are firmly adherent to the chord, at its connection with the placenta; and the covering of the chord itself is most firmly connected with the subjacent substance, so that it cannot be separated like a distinct membrane. The integuments of the abdomen

are continued for a short space over the chord, and there is an abrupt line observed at their termination, beyond which not even the cuticle is continued. The separation is much more strongly marked, when the integuments are minutely injected, by the sudden ending of the injection, no vessel extending into the chord. The tying of the chord without the least pain is a sufficient proof that it has nothing to do with the skin.

The strong connection between the abdomen of the child, and the chord, is produced by the three umbilical vessels, penetrating the tendinous opening of the linea alba. They run externally to the peritoneum, which lies behind them entire and unperforated. The opposite end of the funis is connected with equal strength to the placenta, both by the continuation of the vessels into that body, and by the close adhesion of the chorion and amnios.

Besides the vessels, the urachus, and the coat of the navel-string, it contains nothing but a fine cellular substance, loaded with a transparentropy fluid, giving the part both firmness and bulk. By touching the cut surface of the fresh funis, and removing the finger slowly, we see the fluid so tenacious and ductile, as to be drawn out into fine threads some inches in length. When it has been kept some days, the fluid loses entirely that glutinous quality, and transudes like water; by which means the string loses much of its bulk. In this state, if a small blowpipe be pushed into the interstices of the vessels, and proper ligatures be made, the whole interstitial substance may be rendered emphysematous and white. In this condition it may be dried, and then cut up to shew the cellular substance more distinctly. The great variety that is observed in the thickness or size of the navel-string in different parts, and in different cases, depends principally on the quantity of the cellular substance, and not on the bulk of the child.

Dr. Hunter thinks that "the winding course of the vessels in the navel-string prevents their being much affected by any stretching force, and the firmness of the interstitial substance, protects them against dangerous compression. These accidents might otherwise perhaps have occasioned frequent mischief, especially where there is a large child, and a small quantity of the liquor amnii. In such a case the navel-string passing under the arm or ham, or in the groin, might have been compressed, so as to prevent the return of the venous blood at least. The same thing might have easily happened, where a knot is formed upon the navel-string."

The umbilical arteries divide in the placenta into smaller and smaller ramifications; and their ultimate branches communicate with the umbilical veins; injected fluids at least return very readily by this course. The vein is made up by the union of the minute branches into larger and larger trunks. In the early periods of pregnancy, the umbilical vessels branching out very minutely, constitute the flocculi of the chorion.

*Placenta.*—This, together with the membranes, makes a complete bag lining the uterus, and containing the child. As Dr. Hunter has done much in elucidating its structure, and has given a very good account of the subject, we shall avail ourselves chiefly of his labours.

Its figure is commonly round and flat; it is about an inch in thickness and a span in breadth. It grows gradually thinner towards the edge, so as to render the change from the placenta to the membranes more imperceptible. When the cellular part is well filled with wax, or any fluid, it is at least two inches thick. Its shape is often oblong or triangular, or irregular; and sometimes there is a small lobe or two entirely distinct from the rest. The outer surface, which adheres

adheres to the womb, and is therefore naturally convex, is rough, tender in its substance, commonly covered with blood, lightly subdivided into smaller constituent lobes, and, to a common observer, apparently possessing no blood-vessels, or at least none of any considerable size. The internal surface, naturally more or less concave, is glossy, hard or compact in its texture, and beautifully marked with the ramifications of the umbilical vessels. The navel-string, which produces these branching vessels, is inserted sometimes into the very centre, but more commonly a little nearer the edge, and often into the very edge of the placenta. In four different instances, Dr. Hunter saw the navel-string terminate on the inside of the membranes, at the distance of five or six inches from the placenta. In all these cases the umbilical vessels parted from one another even to considerable distances in their course upon the membranes, and came to the edge and inner surface of the placenta at different places, even at the opposite parts. The termination or insertion of the navel-string, wherever it happens to be, makes the centre of ramification for the large vessels on the internal surface of the placenta.

The human placenta, like that of quadrupeds, is a composition of two parts intimately blended, *viz.* an umbilical or infantile, and an uterine portion. The former is made up by the ramification of the umbilical vessels of the fœtus; the other is a certain portion of the decidua, produced, as we have already described, from the surface of the uterus. The umbilical portion of the placenta is made by a regular ramification of the arteries and veins of the navel-string into smaller and smaller branches, without any lateral anastomosis, so that when unravelled by gentle putrefaction, motion, and washing, this part takes on the appearance of a tree whose branches divide to almost infinite minuteness, not only towards its outer surface, but every where through its substance.

The two umbilical arteries anastomose freely by a canal of communication just where they are going to branch out upon the placenta, so that by injecting one of them, the other is readily filled also. Every branch of an artery is attended with a branch of a vein; these cling to one another, and frequently, in the substance of the placenta, entwine round one another as in the navel-string.

Injections prove, both in the human subjects and in quadrupeds, that the umbilical arteries terminate in the veins of the same name, and not in the vessels of the uterus; and that the blood passes from the arteries into the veins, as in other parts, and so back to the child again. If the placenta be whole in all its substance, which is seldom the case, and its blood-vessels be pretty well emptied of their blood, any subtile injection thrown into an artery will fill the arterial system through the whole substance of the part to an amazing degree of minuteness, and return so freely by the veins as to fill them very generally and equally. In the same manner the whole umbilical system may be filled by injecting the vein, the fluid returning from the veins into the arteries. In both these experiments the injected fluid is confined to the umbilical vascular system, none escaping at the external surface of the placenta, neither by large nor small orifices, whether of veins or arteries.

When a placenta is finely injected, and then steeped, and frequently washed in clear water, it is evident that the umbilical vessels do not reach even the outer surface of the placenta, but are only seen through a membrane (decidua,) which covers all that surface. It is rough or ragged, like the inner surface of the uterus, to which it adheres, and by its whiteness becomes very distinct from the vascular injected part of the placenta, over which it is spread. It becomes still more distinguishable when the part is put into spirits,

which render it more opaque and whiter. This membrane is an efflorescence or production of the inner membrane of the uterus, and is analogous to the uterine fungi of quadrupeds. It receives no vessels, demonstrable by the finest injections, from those of the navel-string, yet it is full of both large and small arteries and veins. These are all branches of the uterine vessels, and are readily filled by injecting the arteries and veins of the uterus; and they all break through in separating the placenta from the uterus, leaving corresponding orifices on the two parted surfaces.

This decidua, or uterine portion of the placenta, is not a simple thin membrane expanded over the surface of the part, it produces a thousand irregular processes which pervade the substance of the placenta, as deep as the chorion or inner surface; and are every where so blended and entangled with the ramifications of the umbilical system, that no anatomist will perhaps be able to discover the nature of their union. While these two parts are combined, the placenta makes a pretty firm mass; no part of it is loose or floating. But when they are carefully separated, the umbilical system is evidently nothing but loose floating ramifications of the umbilical vessels, like that vascular portion of the chorion which makes part of the placenta in a calf; and the uterine part is seen shooting out into innumerable floating processes and rugæ, with the most irregular and most minutely subdivided cavities between them that can be conceived. This part answers to the uterine fungus of the quadrupeds. In a placenta at nine months the two constituent parts can only be separated by some degree of putrefaction, and gentle rubbing and washing; but this operation always destroys the uterine portion, which is more tender, and yields to putrefaction sooner than the other. In the placenta of an earlier age, the union of the two constituent portions is less intimate, and they may both be preserved very entire, like the vascular chorion and fungus of the quadruped. Dr. Hunter separated them in a conception of four months, and left the uterine portion attached to the inside of the uterus.

The two portions of the placenta are so interwoven with each other as to leave innumerable small vacuities, with free communications, through the whole substance. If this cellular structure be inflated or injected, the placenta, like the corpora cavernosa penis, acquires a very considerable increase of thickness, and subsides again when the fluid escapes. This cellular receptacle in the placenta cannot be completely filled after it has been parted from the uterus, because then the fluid, which we may by any contrivance throw in, will be discharged at innumerable orifices on the outer surface of the placenta; but while it remains attached to the uterus, all the cells may be easily and completely filled by injecting any fluid into the arteries or veins of the uterus. These vessels, and these only, have a demonstrable communication with the spongy cells of the placenta, which receive the maternal blood from the arteries of the uterus, and give it back into the veins of that part. Both these vessels pass in the decidua, and the larger branches of both, with little or no ramification, terminate abruptly in the cells. The arteries are all much convoluted and serpentine; the larger, when injected, are almost of the size of crow-quills. The veins have frequent anastomoses, pass in a very slanting direction, and generally appear flattened; some of them are at least as big as a goose-quill, and many of them are very small. They are very numerous round the edge of the placenta, and many run for a little way, in the direction of tangents to the circle, in the very angle between the membranes and the placenta.

In separating the latter part from the uterus, which can be

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effected with very slight force, all these vessels are necessarily torn through; and then each broken vessel has an open mouth on the inner surface of the uterus, and a corresponding orifice on the outer surface of the placenta. They may be readily observed on a fresh placenta, as soon as it has come away in a common labour. Air blown into the cellular part by thrusting in the end of a blow-pipe, rushes out readily by the open mouths both of the arteries and veins.

While the placenta remains adhering to the uterus, injection will pass either from the uterine arteries or veins into the cells of that organ; and, after filling these cells, it returns by the opposite order of vessels to that by which it was thrown in. Hence, if we wish to inject both systems in the gravid uterus, we should fill the first only moderately, and then the other.

The venous system of the decidua and uterus may be filled with air from the cells of the placenta. Introduce a blunt probe through a slit in the coat of the navel-string, and force it into the cells of the adjacent part of the placenta; then, withdrawing the probe, insinuate an injecting pipe, and tie it firmly with a broad thread round the navel-string. By that pipe you may fill the whole placenta uniformly in its cellular part, and likewise all the venous system of the uterus and decidua, as readily and fully as if you had fixed the pipe in the spermatic or hypogastric vein; so ready a passage is there reciprocally between the cells of the placenta, and the uterine vessels. It is as much reciprocal, and more largely open, than between the corpus spongiosum and the veins of the penis.

From all his experiments, repeatedly and diligently made, Dr. Hunter concludes, that the human placenta, like that of the quadruped, is composed of two distinct parts, though blended together, *viz.* an umbilical, which may be considered as a part of the fœtus, and an uterine, which belongs to the mother; that each of those parts has its peculiar system of arteries and veins, and its peculiar circulation, receiving blood by its arteries, and returning it by its veins; that the circulation through these two parts of the placenta differs in the following manner; in the umbilical portion the arteries terminate in the veins by a continuity of canal, whereas in the uterine portion there are intermediate cells, into which the arteries terminate, and from which the veins begin. Though the placenta be completely filled with any injection thrown into the uterine vessels, none of the wax finds its way into any of the umbilical vessels; and in the same manner fluids injected into the umbilical vessels can never be pushed into the uterine, except by rupture or transfusion.

Several views of the arteries and veins, which pass from the uterus to the placenta, are exhibited in Dr. Hunter's plates; see Tab. 15. fig. 1. Tab. 19. Tab. 29. fig. 1. and Tab. 30. and the same vessels on the surface of the uterus in fig. 3. Tab. 10. and fig. 2. Tab. 28.

It has been stated already, that the human placenta is made of a single mass; but some varieties have been observed in this respect. It possesses sometimes a small appendix; or it may be made up of three or more small pieces, united by means of the chorion. Wrisberg saw a placenta composed of seven pieces. Where there are twins, or three children, the placenta is usually single; but there may be two or three separate ones united by the amnios, which forms the partition of the bags containing the children.

*The Fœtus.*—The proportions of parts, and consequently the whole figure of the fœtus, differ very much before birth, from that which they possess afterwards; and they differ also very considerably at different periods of utero-gestation. Influenced by their opinions of the beauty and

due proportions belonging to the human frame in later stages of existence, many have called the fœtus, in its early periods, shapeless and destitute of symmetry; not reflecting that a different figure and relation of parts belongs, in the order of nature, to the age we are speaking of, and that this may still be beautiful and symmetrical according to the standard of that age. While the rose is still inclosed in the calyx, its appearance is very different from that which it exhibits when the petals burst forth from their confinement, and the whole flower is displayed in its mature and perfect state: yet we do not deem the rose bud inelegant or imperfect in its form. We may affirm, on the same principles, that every age in the human subject is distinguished by its peculiar kind of beauty; that the embryo, the fœtus, the infant, the youth, &c. possess their respective proportions, those of each differing from the others; and consequently, that an embryo may, with propriety, be termed beautiful, if its formation correspond to the standard of its age. It is true, indeed, that the fœtus in abortions is often ill-formed, being smaller than it should be, deviating from the usual proportions, or monstrous; and, very probably, this mal-formation may be one of the causes why such embryos die, and are separated with the ovum from the uterus; just as we see that mis-shapen or worm-eaten fruits seldom arrive at maturity, but have their further growth impeded by that very cause. To the same purport it is observed by Autenrieth, § 8, "that he found three monstrous fœtuses, out of nineteen, whose parts could be distinguished; that Wrisberg met with two among five, which he examined; and Ruysch two in twelve; the proportion of the whole being seven in twenty-nine. This large number, (if we consider, at the same time, that all the collections of anatomical preparations abound with monstrous fœtuses, which have died immediately after birth, while adult monsters are extremely rare,) renders it very probable that nature employs the short, but effectual means of extirpation, in order to preserve the genuine figure of the human frame, and that one model only, of all those into which the human frame may pass, is endued with permanent vital powers." This author observes also, that a greater number of abortive embryos are of the male than of the female sex; and this observation is confirmed by Soemmering, who extends it likewise to monsters.

It is extremely difficult to ascertain at what exact time the fœtus of an ovum becomes visible; because it is almost always impossible, in the human subject, to ascertain the date of the impregnation. Dr. Baillie states, that he saw a preparation in the possession of Dr. Combe, where, from peculiar circumstances, it had been ascertained that the conception was twenty-two days old, and where the fœtus was visible, although extremely small. In an abortion, which came away after the first cessation of the catamenia, dissected by Blumenbach, and exhibited in the 4th table of his "*Institutiones Physiologicæ*," the amnios was about the size of a large pea, but no vestige of the fœtus could be discerned.

The following account of the successive developement of the embryo is derived chiefly from Soemmering's work, "*Icones Embryonum Humanorum*," which is chiefly devoted to this subject, and exhibits a most beautiful series of embryos from the earliest period to the fifth month.

Generally speaking, the embryo grows the most rapidly in the first weeks after conception; the rate of its progress afterwards diminishes to the ninth month: this growth, however, does not proceed uniformly at all times. It is gradually retarded in the second month, accelerated in the third; stopped again in the beginning of the fourth, and

continued

continued more rapidly from the middle of that month to the sixth; from which time it is again retarded till the period of maturity. A similar observation has been made concerning the chief viscus of the embryo, by Walter, the son. (Annot. Acad. de hepate, § 8.) He found that the rapid and prodigious growth of the liver did not continue beyond the end of the fourth month. It appears, moreover, that different parts of the body of the embryo grow very differently; and that some arrive at a certain degree of perfection sooner than others.

The younger the embryo, the larger is the containing ovum. That part, therefore, in proportion to the fœtus, is the largest, most capacious, thickest, and firmest, in the earliest periods after conception; and the smallest, thinnest, and most tender, at the complete term of utero-gestation. At the middle of pregnancy it exhibits an intermediate state between these extremes.

In the first and second months the embryo is completely bent; a little straightened in the following month, and afterwards, as the limbs increase, convoluted into a kind of oval shape. The head is brought forwards on the chest during the whole period of utero-gestation. The younger the embryo, the greater is the bulk of the head, compared to that of the trunk; or, what is equivalent, the trunk is smallest at that time. The head must consequently be the largest when it can be first distinguished. In the first month the head considerably exceeds the size of the rest of the body. Its growth goes on less rapidly after this time, and does not exceed that of the trunk; so that at the age of five months, it bears a moderate proportion to the body. The younger the embryo, the smaller is the face, in comparison to the cranium. The pyramidal proportions of the temporal bones are particularly large in the first month.

The neck, corresponding in some degree to the size of the head, is large and short; so short, indeed, that it can hardly be recognized at all in the first and second months, being marked by the slightest constriction. It is scarcely distinguishable before the third month, on account of the head being bent forwards.

The extremities are smallest, in proportion to the trunk, in the youngest embryo. They first shoot out from the trunk in the form of hemispherical tubercles, like buds from a tree; are protruded a little further, and elongated in the second month; at which time, the upper limbs may be distinguished into arms and hands, and the lower into legs and feet. Then the fingers arise, like little papillæ from the hands; the arms and fore-arms being more developed; at the same time thighs, legs, and feet, may be distinguished in the lower limbs, but the latter are still without toes. These, however, shoot out at the end of the second month, the fingers being at the same time elongated. In the three first months the upper limbs exceed the size of the lower ones; they become nearly equal in the fourth; and in the fifth the lower ones have acquired that superiority which they afterwards retain.

The lower part of the spine is at first curved round towards the belly, so as to resemble somewhat the tail of a quadruped, when thrown between the hind legs. This prominence, sometimes called *tuber coccygeum*, is largest in the two first months, projecting beyond the lower limb, so as to give the spine a keel-like form. It gradually disappears in the third month, as the lower limbs are elongated.

The eyes are first observed, of the organs of sense, and are larger and more prominent as the embryo is younger. They are seen very distinctly in a beautiful and, as it should seem, perfectly formed fœtus of the first month, not larger than a middle sized pea, represented by Soemmerring. They

may always be recognized, in the very youngest embryos, by a deep black circle. Before the second month either the eye-lids are open, or so thin, that the black pigment of the bulb is discerned through them. Soemmerring thinks that the eye-lids are really open until about the tenth week, when they are closed. After that time he has always found them firmly shut, and the slit between them shorter than the diameter of the globe. The circle of the iris, which is of the deepest black, is completed sooner on the outer than the inner side.

Very small pores are seen in the situation of the external ears about the seventh or eighth week; the middle of the helix then rises from the head, and is followed successively by the tragus, antihelix, antitragus, lobulus, and upper part of the helix. The ears are completed by the formation of the concha and scapha in the fifth month. Their proportions are still very different from those of the adult. Two small holes at first occupy the situation of the nose, which itself gradually shoots out about the seventh week; the dorsum, alæ and septum are distinguishable in the eleventh week. The mouth is largest in the first months; and is open, without any lips. The latter parts are distinctly formed about the eleventh week, and are firmly approximated, so as to close the mouth, from the third month.

The genital organs, scarcely distinguishable in the first weeks, have acquired a considerable size at the commencement of the third month. The penis is large and prominent about the twelfth week, and the glans uncovered; the scrotum is small and empty until the 9th month. Sometimes it is loose, and distended with water; sometimes corrugated. A small slit is sometimes discerned in the female in the second month. The clitoris is large and prominent in the third month, like the corresponding organ of the male; so that a female embryo, viewed laterally, might be mistaken for one of the other sex. About the fourth month the clitoris hangs more downwards, but is still large even in the fifth.

The umbilical chord at first is short, but large; it sometimes equals the trunk in very small embryos. Afterwards its length increases, but the relative breadth diminishes. Its surface is always unequal and knotted.

Soemmerring has remarked that the sex of the youngest embryos can be distinguished, independently of the genital organs, if they are well proportioned. The most striking difference is found in the structure of the thorax. That of the male is longer, more conical, formed of thicker ribs, and more prominent, with respect to the abdomen and pelvis, than that of the female. In the latter, not only is the whole thorax shorter, but also rather larger above, as far as the fourth rib, and therefore less conical. It is more distant from the pelvis, on account of the greater interval between the last rib and os innominatum, and less prominent, so that where the body is either erect or supine, the symphysis pubis is the most prominent part in the female, and the thorax in the male subject.

The abdomen begins higher in the female, and is large and prominent, expanding towards the genitals: we might say that the female thorax is compressed, and the abdomen tumid.

The distinction is so obvious, in respect to the points now mentioned, that it will not only be readily observed in the well formed embryos carefully compared; but it may even be thought strange that it should have hitherto escaped observation. It will often be noticed, according to Soemmerring, in very small embryos; and if we can ascertain the sex by the organs of generation, we shall readily perceive the distinction in the form of the chest.

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The form of the head exhibits another sexual distinction. It is on the whole larger in proportion to the body, but less rounded in the male than in the female: the occiput too is convex, so that the neck is hollowed in appearance, and the vortex is flattened. In the female the form is more globular, the occiput not prominent, and the neck consequently not hollowed, and the vortex spherical.

Some points of distinction may be seen also in the extremities; of which males have the superior rather larger, the scapulae stronger and more prominent, and therefore suitable to the stronger thorax of this sex, the arms rather conical, the fore-arms more muscular, the carpi broader, and the ends of the fingers more obtuse. The lower limbs, adapted to the narrow male pelvis, are contracted above; the thighs are more slender, but the feet very strong, with prominent malleoli and heels. The great toe exceeds the others in size very remarkably. The characters of the female are just the reverse of these. The upper limbs are shorter, with the scapulae more sloping, the arms cylindrical, fore-arms slender, wrists narrow, and ends of the fingers acuminate. The lower limbs, from the superior breadth of the pelvis, are largest above, and diminish conically towards the knees; the heels and ankles are not prominent, and the great toe exceeds the others but slightly.

The spinous processes of the inferior dorsal, and superior lumbar vertebrae form a kind of projecting ridge in the back of the male, where the female presents a depression. The same difference is seen not only in the mature foetus, but also in infants, and in the best proportioned boys and girls.

After describing the progress of the embryo, and the differences of the male and female at this early period, Soemmering alludes to the much disputed question, whether the same powers of body and mind are bestowed on all men, or whether there be not natural diversity in these in different individuals, arising from original differences in the structure of the frame. Attentive examination will shew that the bodies of embryos are marked by native traits of distinction, clearly recognisable at a time, when neither food, education, habits, clothing, nor the operations of disease can have exerted any influence on them. Not to mention that foetuses are born, who, from too delicate an organization of the eyes, shun as the greatest evil, that light, which is our first blessing; that imperfection in the structure of the ears incapacitates some from the ordinary business of life; that others are almost cut off from human society by deficient formation of the organs of voice; that mal-formation of the heart devotes some to an existence of constant suffering, incapable of all exertion of body and mind, while deformity of the limbs circumscribes the powers of others; that many are born without brain, and therefore utterly destitute of all mental faculties; putting all these circumstances out of the question, we notice great differences in the form and proportions of well made embryos. Wide differences exist in the shape, capacity, and firmness of that part of the head which lodges the brain; the countenance varies infinitely in the distance, size, and form of the organs of the external senses; and there are marked diversities in the volume of the chest, and in the strength and form of the limbs.

To our account of the progressive development of the different parts of the body, we shall subjoin a short description of the foetus in its different periods. In the first month it consists of a mere jelly; which is easily destroyed by very little touching, and evaporates almost entirely by heat. Authors have delineated embryos at the end of the first month of the size of a barley corn; or a pea. Soemmering gives a representation of one very elegantly formed, no lar-

ger than a very small pea. At this time the head is fully developed, and much exceeds the rest of the body. The cranium is particularly large. The eyes and mouth are discernible. The figure of the whole is globular, the head and spine being strongly bent towards each other. The position of the bodies of the vertebrae is discernible. The arms are two very small tubercles; the lower extremities are the same; and the coccygeal tubercle is a larger prominence between the right and left of the latter limbs.

In the second months the body becomes more firm and opaque, and its parts are more developed. The mouth and nose are discernible; the eyes distinguished by their blackness; and the ears can hardly be seen without the aid of the microscope. The whole figure is strongly incurvated, so that the coccygeal tubercle, which is larger than the rudiments of the lower limbs, nearly touches the head. At the end of this month the fingers and toes are discernible. Ossification also commences; first in the clavicles, the large cylindrical bones, the lower jaw, frontal and occipital bone; &c. The body may now be half an inch long. The umbilical chord, very short and thick, connects the child closely to the ovum. In the end of the third month the features are well formed. The forehead is very prominent. The general figure still incurvated. The coccygeal tubercle diminishes and disappears. The extremities are fully developed, and the fingers and toes perfectly distinct. The organs of generation are clearly seen; the penis and clitoris being very large, the nymphæ prominent, and the labia thick. The abdomen projects towards the umbilicus. Soemmering has given a most exquisite figure of a male embryo of about 12 weeks. The eye-balls are clearly distinguishable, larger than the opening of the lids. The nose is well formed; and even the philtrum is clearly discerned in the upper lip. There is scarcely a vestige of the coccygeal arch. The size and form of the scapula is evident, and the parts of the extremities in general distinctly seen; even the prominence of several muscles, as the deltoid and biceps, gluteus major, vastus externus, &c.

In the fourth and fifth months the form and proportions approach constantly more nearly to those which the body possesses in future. All the external parts are clearly distinguishable in the 14th and 15th weeks; except the hair and nails. Hitherto the foetus was surrounded on all sides by a large quantity of the water of the amnios; but as it grows now more rapidly than the ovum, it occupies the cavity of that part more completely. The head, in the fourth month, on account of its considerable size when compared to the body, sinks constantly lower in the uterus. The foetus comes completely in contact with its coverings in the fifth and beginning of the sixth months, and consequently the mother usually begins now to feel its motions. On a very rare occasion, Wrisberg saw clearly, for a few minutes, a slight motion of the arms and feet in a foetus of 130 days. He could not discern any beating of the heart or arteries; neither did the muscles of respiration act, when he inflated the lungs. In the sixth month the membrana pupillarum of the eye is very visible. The scrotum is still empty and corrugated. Hair and nails are formed. The integuments still hang rather loosely on the body, so that it has a lean and wrinkled appearance. In a foetus of between 5 and 6 months, the length of the body was 10½ inches; and that of the head, from the vertex to the lower jaw, 3¼ inches.

The length of three foetuses, whose ages were 158, 162, and 170 days, varied from 16 to 19 inches; and their weight from 1lb. 10 oz. to 1lb. 13 oz. All three came into the world alive: the pulsation of the arteries could be clearly felt,

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felt, they respired, but cried feebly. They moved their limbs freely, could not suck, but swallowed milk which was poured into their mouths; and they lived several hours.

The size of the fœtus is considerably increased in the last three months. The greater comparative growth of the limbs makes it appear as if the head became smaller; the latter part is about one-third of the body in a newly born child. More fat is accumulated under the skin, so as to make the outline of parts more rounded.

The increase at this time is rather in breadth and thickness than in length. The hair grows longer, and the nails more firm. The *membrana pupillaris* disappears, and the testes descend into the scrotum. A child of seven months can live a few hours only out of the uterus, and those of eight months seldom live a fortnight.

The fœtus is fully developed and mature, so that it can live out of the uterus at the end of the ninth calendar month. Experience has shewn that children may live, when born a fortnight or three weeks before this time, if well taken care of; and it seems probable that a longer interval may elapse before birth: but the necessary uncertainty of the mode of reckoning renders the point dubious. The proportions of parts are very different in the fully grown fœtus from those of the adult. The head is extremely large; and the upper part of the trunk, and upper extremities, are very considerable when compared with the lower parts.

“The size and weight of a child’s body at birth, says Dr. Hunter, are generally over-rated in this country; inasmuch that we are often told, even by those who ought to know, of children weighing from 15 to 20 pounds. So far is this from being true, that I never knew an instance of a child which weighed 12 pounds, and the greatest number a little above half that weight. Dr. Macaulay was at pains, at our hospital, to ascertain the ordinary bulk of newborn children, by first weighing a great number indiscriminately as they were born; and then by giving an order to our matron to weigh occasionally all such as were of a remarkable size in either extreme. Of several thousands born in the British hospital at their full time, while the doctor’s order was attended to, the smallest weighed about four pounds, the largest 11 pounds two ounces, and by far the greater number weighed from five to eight pounds, avoirdupois. In cases of twins, it seldom happens that each attains the weight of a single child. It has been remarked that the first is usually the strongest.”

The measure and weight of the fœtus cannot be much depended on as criteria of its being mature or otherwise: yet if a child is much under between six and five pounds, and shorter than eighteen inches, it may be deemed immature. The following are also characters from which we draw the same conclusion. Thinness of the body, and mobility of the skin; a reddish livid colour of the surface, particularly in the palms and soles, probably from the blood shining through the thin integuments: and a fine woolly covering of the body. Mobility of the parietal bones, and great size of the fontanel. Thinness and shortness of the nails. The eyes being much closed, and the child not looking about at surrounding objects. Coldness of the hands and feet.

The growth of the child, during its residence in the uterus, is very considerable compared to its subsequent increase. According to Haller, (*Element. Physiol. lib. 29. sect. 4. § 17.*) it increases in the first month to a bulk 300,000 times greater than its original size. In the second month its increase is to 48 times the size it possessed at the end of the first. From this time to the full period it will only average an increase of 15 times for each month. At

the end of the three first years, the proportion to the mature fœtus is as 14 to 5: and at the end of the 22 following years, the proportion to an infant of three years, as 8 to 1. The increase in the first month of existence is to that of the last month of growth as 4,885,717 to 1, and the whole increase is from 1 to 108,000,000,000.

The number of twin-cases to single births, according to Süßmilch, is as 1 to 65 or 70: by the same calculator, one instance of three children occurs in 6500 births; but probably it does not happen so often. Four children are extremely rare, and the cases of five are still more extraordinary. Twins live often enough; three children but seldom; and four, perhaps, never.

As a general observation, it may be stated that male children are larger than females. Dr. Clarke of Dublin has given us some interesting facts on this subject from a register of 20,000 births, in a paper contained in the 76th vol. of the *Philosophical Transactions*. The weights of sixty males and sixty females were as follows, leaving out fractions:

		Males.							
lbs.		4.	5.	6.	7.	8.	9.	10.	
Number of children		0.	3.	6.	32.	16.	2.	1.	
		Females.							
lbs.		4.	5.	6.	7.	8.	9.	10.	
Number of children		2.	9.	14.	25.	8.	2.	0.	

He found the dimensions of the head in the male to exceed those of the female: thus, of 120 children, six only measured more than 14½ inches round the head; and all these were males. This greater size of males exposes them to greater difficulty in the birth, and consequently a greater number dies in that process; one half more than of females. The proportion of males born to females was nine to eight: but, in consequence of the greater mortality of the former in parturition, and the first days of existence, the balance in favour of the male sex, out of 20,177 children, was only 483 at the end of a fortnight, although originally 1177. In countries where polygamy is allowed, more females are said to be born than males.

*Position of the Child.*—“The fœtus in utero,” says Dr. Hunter, “is naturally contracted into an oval form, adapted to the figure and circumstances of its habitation. The vertex of the head makes one end of the oval, and the nates the other; one side or edge of the oval is formed by the occiput, the back part of the neck, and the incurved trunk; the other is made by the forehead, and the mass of contracted and conglomerated limbs. The chin is close to the breast, the trunk is bended forwards, the knees are close to the fore parts of the hypochondria, the legs drawn to the back parts of the thighs, the feet or lower parts of the legs decussating each other; and the upper extremities contracted into the vacant space betwixt the forehead and knees. The most common situation of the extremities is not to be determined, as they are found to be a little different in different dissections; and in the living body they vary almost every moment: thence the hands are seen indiscriminately on the head or face, or across one another, or round the knees, or legs; and the legs are sometimes extended, and the feet are placed by the face; or one is in that position, and the other contracted, and the foot downwards.”

“The navel-string, in passing from the child to the placenta, is often variously entangled with the extremities, and frequently winds once or oftener round the neck.”

“When there is a considerable quantity of liquor amnii, the child takes the advantage of room, and the composition of its parts is not so close or globular. In proportion as there

there is less room, its figure is more compacted and moulded to the shape of the cavity of the uterus. In two different cases which I examined, there was so little fluid surrounding the child, though the waters had not been discharged, that the uterus had pressed and moulded all parts of the child into a very ugly form, as if it had been made of dough: and in such cases the hands and more particularly the feet are liable to be compressed and twisted into deformity, on account of their being projecting or pliant parts.

“With regard to the mother, the most common situation of the child, by far is, with its head downwards, and its nates at the upper part of the uterus. Once, perhaps, in twenty or thirty cases, it is the contrary, and presents, as they term it in midwifery, with its posteriors. All the observations that I have been able to make in dissections, and in the practice of midwifery, would persuade me that the child's head is naturally downwards through all the later months of utero-gestation.”

By the position of the fœtus, as we have now described it, rolled up and compacted into an oval figure, it takes up the smallest possible room in proportion to its size. It distends the uterus too equably: and, in order to fulfil this object more completely, the intervals left by the inequalities of the child's body are filled with a fluid (the liquor amnii), and the whole is contained in membranes, so as to form a perfectly oval mass, distending the uterus in all directions. Hence the fluid is more copious in younger embryos, because they cannot be compacted into an oval mass, and are too tender to distend the uterus.

The peculiarities of structure, in various parts of the body, which distinguish the fœtus, will come under consideration, most properly, when we describe the different parts in which they are found. We shall, therefore, merely enumerate them on the present occasion.

The surface of the body is covered every where with a firm sebaceous and white substance, called by some vernix caseosa. This covering, which renders the whole body greasy, cannot be washed off with plain water. It is insoluble in alcohol, oils, or pure water: but some alkalies dissolve part of it, and form a kind of soap. It has often been supposed that this is a sediment from the liquor amnii; but that is very improbable, as the liquor amnii contains nothing unctuous, and there is none of it on the amnios or navel-string. It must, no doubt, be a secretion from the skin.

The cutis, at first thin and gelatinous, is covered by a cuticle in the earliest stages. Proper fat is not formed under the skin before the fourth month; its place is occupied by a kind of jelly-like substance. Afterwards a pretty thick layer of fat is formed over the whole body, next to the skin; but there is very little about the viscera or internal parts: little among the muscles, or in the bony structure. The skin has a very red and vascular appearance; and is said to have this appearance, even in negroes, who are affirmed to change to the black colour a few days after birth. A soft woolly covering, seen particularly about the sides of the face, the back, shoulders and ilia, in young embryos, disappears in the mature fœtus.

The state of the bones in the fœtus has been already alluded to in the article BONES. The jelly, of which the embryo is first composed, becomes more firm and consistent in the fourth and fifth weeks. The materials of the parts which will afterwards be bones, are first changed from the gelatinous consistence, common to all the organs, into cartilage, at first soft and tender, and assuming gradually firmness and elasticity. Its figure represents that of the future bone. It loses its transparency, and white opaque spots

are discerned in it (*puncta ossificationis*) about the seventh or eighth week after conception. These are first observed in the clavicles, ribs, vertebrae, large cylindrical bones, lower jaw and other bones of the face, os frontis, and occipitis. Large vessels are seen ramifying through the cartilage, and distributed on the ossifying points; these secrete the osseous matter, which is there deposited. In simple flat and small bones there is a single point, from which the osseous deposit extends into the rest of the bone. In most others, particularly such as have an irregular figure, there are two, three, or more points, beginning at the same time, and extending in their circumference until they meet. Such bones consist of certain pieces in the fœtus and young child, united by plates of cartilage. In other bones, particularly of the long kind, a principal point is observed at first, forming the body of the bone, or diaphysis. Afterwards, smaller points arise, especially at the ends, which had hitherto remained cartilaginous. These are called epiphyses, and, after their ossification has proceeded considerably, they are still connected to the body of the bone by a plate of cartilage. The ossific points generally commence in the very middle of the cartilage, and extend thence into the circumference. They differ in appearance in the different bones. In the flat ones, particularly of the head, they are thin reticulated scales, perforated with innumerable small holes. The bony fibres, as they are called, extend, in these scales, in a radiated manner, from the centre to their circumference: in the long bones they are short cylinders, with a small depression at each end, and possessing, apparently, parallel fibres: in the round bones they are globular granules; and in those of irregular figure, irregular in their outline, and generally possessing several points.

At the time of birth the ossicula auditus, labyrinth, and tympanum, are completely formed; all the other bones of the body are in a more or less incomplete state.

Physiologists in all ages have attempted to explain how ossification is effected, in what manner the cartilage is removed, and bony substance put in its place: which points we shall probably understand, when the hitherto unveiled mysteries of secretion and nutrition are completely laid open to our inspection. In the mean time, instead of bringing forwards a series of old hypotheses, we shall just quote a passage from Albinus, (Annot. Acad. lib. 7. p. 76). “We may conjecture that there exists, from the first origin of the embryo, rudiments of the cartilages, however small, soft, tender, and approaching to the nature of fluid: or at least that something is generated at that time, which is afterwards cartilage. But of the essential nature of cartilage or bone; of the manner in which cartilage is substituted in the place of bone; how either cartilage or bone is formed from our aliments; and what particular part of the fluids furnishes the materials of this growth; we must confess ourselves ignorant, and shall probably remain so.”

The bones of the fœtus contain much more animal matter, and less earth than those of the adult; they are consequently of a greyish colour, and acquire more of a white or yellow hue, as they advance towards their perfect consistence. The extremities of the long bones, on account of their numerous blood-vessels, are dark coloured. The periosteum is strong and thick, and separates easily. The place of marrow is supplied, in the embryo, by a mere gelatine, which acquires somewhat of a fatty or oily nature towards birth.

The younger the embryo, so much larger is the head in proportion to the trunk and extremities; so much smaller are the bones of the face compared to the cranium; so much larger the organs of hearing; and so much lower and flatter is the lower part of the face. The internal surface of the skull

Skull has no marks arising from the convolution of the brain, nor any grooves for the blood-vessels. The cranium is at first merely membranous; the mode in which it is ossified has been already considered under the article CRANIUM. We may just enumerate here, as peculiarities of the foetal cranium, the want of the frontal, sphenoidal, and maxillary sinuses, of the mastoid processes, and of the meatus auditorii externi, and the imperfect state of the ethmoid sinuses. The condition of the jaws, with their contained teeth, has been considered at large in the article CRANIUM.

The os hyoides has scarcely begun to ossify at the time of birth.

The cavity of the thorax is proportionally larger than in the adult, and more conical. Blumenbach attempts to account for this size by the peculiarities in the circulation, and the consequently greater bulk of the liver. The pelvis is very small, so that there is no room in it for the urinary bladder. The individual bones of the chest and pelvis, as indeed of the rest of the body, will be more particularly described in other articles.

In the upper extremities, the clavicles begin to be formed very early, and attain to a very large size, when the rest of these limbs is extremely small. Thus in the tenth week they are three times the size of the femora. The scapula is also considerable at an early period, and has a piece of ossification double the size of that in the os innominatum. The carpus is completely cartilaginous, as is the tarsus in the lower limbs, excepting the astragalus and os calcis, each of which possesses a small ossific point. The ossification proceeds afterwards more rapidly in the tarsus than in the carpus, probably on account of the erect stature of the human subject, and the share which the tarsus has in supporting the body in that position.

All the bones of the embryo are uniform on their surfaces, where, in the adult, elevations and impressions are found.

The muscles can hardly be distinguished in the three first months, like the rest of the soft parts they seem composed of a mere jelly. The fibrous texture becomes discernible in the following months; when we are able to distinguish tendons also. Such, at least, is the observation of Wrisberg, in an embryo of  $5\frac{1}{2}$  months. The tendons, which are fixed to the bones of the adult, terminate in the periosteum and perichondrium of the foetus, and come away entirely with these membranes.

It is observed, by Soemmerring, that the tendons of the recti abdominis are proportionally broader and stronger than in the adult. The pyramidales are considerably larger. There is a round opening in the linea alba for the passage of the umbilical vessels. The muscles of the internal ear are nearly complete at the time of birth; the intercostals and diaphragm are considerably developed at the same period, and the muscles of the upper more than those of the lower extremities.

The eyes are developed at a very early period, being distinctly visible in the youngest embryos hitherto observed. They appear as black points at the end of the first month. The pigmentum is visible from the first, and is particularly thick and black. It has been correctly observed by Hogarth, that no part of the body grows so quickly, and is so perfect in the foetus, requiring no additional growth after birth, as the iris. The cornea, crystalline lens, and vitreous humor, have a reddish tint. The lens is spherical in its figure. That great peculiarity of the foetal eye, the membrana pupillaris, will be described in the article EYE.

The external ears are developed rather late, as there is

not the slightest trace of them at the end of the first month. The meatus externus is often filled up with the vernix caseosa. The membranous texture of the whole meatus; the covering of the membrana tympani by the membrana mucosa; the attachment of that membrane to the annulus auditorius; the want of mastoid cells are all further explained in the article EAR.

The formation of the nose commences late; and the cavity is small and very incomplete in the foetus, as a necessary consequence of the state of the bones of the head at that time.

The thyroid gland is large and vascular in the foetus.

The thymus, which is of very considerable size before birth, and gradually disappears afterwards, will be considered under that article.

The lungs are small, collapsed, of a red colour, and sink in water.

The mammae are large in proportion to the size of the body. The papilla is small, and not yet surrounded by an areola. The breasts of the male and female foetus do not differ: they contain a whitish fluid, which can be forced out by gentle pressure, and sometimes flows spontaneously in children.

The abdomen is very large in the foetus, and is drawn into a conical form towards the navel in young embryos. The great size of the abdomen may be accounted for by considering, that this cavity holds the bladder, and that the liver and renal capsules are very large. The distance from the end of the sternum to the pelvis, in a newly born child, is one-third of the length of the body; in the adult it is not one-fifth.

In the alimentary canal of the foetus, we observe an almost entire want of valvulae conniventes in the small intestine; and of appendices epiploicae in the large. The appendix vermiformis is a gradual conical contraction of the caecum. The intestines are more or less filled with a soft matter, of a yellowish green colour in the small, and of a dark green, approaching to black, in the large, called meconium. There is very little of this near the stomach; it increases in quantity lower down, and is the most abundant in the large intestines. But in the early months, the latter part of the canal contains no meconium. It is not distinguished by any peculiar taste or smell.

The pancreas is large, and the liver of immense size in the embryo. The kidneys are also considerable, and lobulated on the surface. The renal capsules equal the size of the kidneys. The urinary bladder is very large, equalling the dimensions of the stomach.

The situation of the testis in the abdomen, and its passage from that cavity into the scrotum, will be considered when the testis itself is described.

The heart is proportionally large in the foetus, and occupies a considerable part of the thorax. Hence, on exposing that cavity, this viscus comes immediately into view, and seems in a manner to cover the lungs. The foramen ovale, by which the two auricles communicate; and the equal strength of the two ventricles, will be considered when the heart itself is described. The pulmonary artery of the foetus divides into three branches, of which the middle is the largest. This is termed the *ductus arteriosus*, and it runs directly to join the aorta, immediately below the arch of that vessel. It is often named after Botall, although Galen and others knew it. Its length is about equal to a finger's breadth. It conveys into the aorta a large part of that blood which passed from the right auricle into the right ventricle; more than half of it, according to Haller. This canal is closed very soon after birth, often within a few

days. The umbilical vessels have been already described in a former part of this article. The arteries are found obliterated from the navel to the bladder, very soon after birth, often within a very few days; near the bladder they are very much contracted, but not closed, and give origin to the arteries of the bladder. The umbilical vein, and ductus venosus are closed in the same way. The mode in which the circulation is carried on through the parts now described, is represented in the article CIRCULATION.

The coverings of the brain are at first so thin and transparent, that this organ can be seen through them. It is almost fluid until the 5th or 6th month, and remains very soft even to the time of birth, so that its dissection is difficult. It is always larger in proportion to the body, the younger the fœtus. The nerves are larger in proportion to the body.

*Physiology of fetal existence.*—Some remarks on this subject will be found in the article CIRCULATION. We have only to observe, further, on the subject of the connection between the mother and child, that the mode by which this is effected, notwithstanding it has been a favourite subject of research with the greatest physiologists of all ages, remains still a problem. The account which we have given of the structure of the placenta, shews that the arteries and veins of the uterus have communications with the substance of the former organ; we are, however, entirely unable to state how the blood of the mother, or any nutritive fluid, is admitted into the umbilical vessels; although the obvious impossibility of the fœtus deriving the materials of its growth from any other source, leads us to conclude, without hesitation, that such admission must take place. The reader will probably think that the following quotation, containing Mr. Hunter's opinion, does not tend to elucidate materially this obscure question.

“The blood, detached from the common circulation of the mother, moves through the placenta of the fœtus, and is then returned back into the course of the circulation of the mother, to pass on to the heart.

“This structure of the placenta, and its communication with the uterus, leads us a step further in our knowledge of the connection between the mother and fœtus; the blood of the mother must pass freely into the substance of the placenta, and the placenta most probably will be constantly filled; the turgidity of which will assist to squeeze the blood into the mouths of the veins of the uterus, that it may again pass into the common circulation of the mother; and as the interstices of the placenta are of much greater extent than the arteries, which convey the blood, the motion of the blood in that part must be so much diminished, as almost to approach stagnation.” (Obs. on certain parts of the Animal Economy, p. 135.)

The existence of the fœtus is purely vegetative. Constantly receiving the materials of its nourishment and growth from the juices brought to the placenta by the vessels of the mother, it may be regarded as a new organ produced by conception, participating in the general life, but having its own peculiar life, which is, to a certain degree, independent of that of the mother.

The animal life, or that class of functions by which the animal is connected to the external world, has not yet commenced in the fœtus. Its state therefore cannot, with any justice, be compared to that of a person asleep, in whom these functions are only suspended: but in the fœtus they have not begun.

The fœtus can have no sensations from the surrounding medium: its temperature being invariable, it can have no

object of comparison, which is essential to sensation. The senses cannot act, because none of the causes, which excite them, have hitherto operated. That of touch, being dependent on the others, and serving to rectify the conclusions which they tend to, must of course be inactive. This inaction of the senses supposes a similar state of their nerves, and of the brain. Transmission of impressions is the function of the former; perception of the latter: but neither of those acts can take place when there are no objects to be transmitted or perceived. Memory and imagination flow immediately from perception: judgment arises from one of these three, and gives origin to the will. This connected series of faculties has not begun in the fœtus, because of the want of sensations. The brain is capable of acting, and possesses all the requisites for action; it is not *excitability* but *excitation* that is wanted. The fœtus moves while contained as the uterus; and these motions are considered as symptoms of pregnancy. As all motion arises from some foregoing impression, and as the senses of the fœtus are completely inactive, it is difficult to assign a satisfactory cause for these movements of the child.

The functions of organic life, or those by which the nutrition and growth of the body are effected, must commence almost as soon as the fœtus is conceived. The matter of nutrition arises in its body in an assimilated state, having been prepared by the mother: it enters immediately into the circulating system, without traversing the digestive organs, then nearly inactive. The organs of excretion, which decompose the body, as the lungs, skin and kidneys, are also almost inert. The secretions have hardly commenced.

To the great simplicity of the assimilative process in the fœtus, let us add the remarkable activity of the organs employed in it; an activity which depends on the greater proportion of their vital powers. The whole force of the animal economy seems to be concentrated on the two systems of circulation and nutrition; the processes of digestion, respiration, secretion, and exhalation being exercised, at most, but feebly: the diminished energy of the latter being made up by the increased power of the former. If we consider, moreover, that the organs of the animal life, condemned to a necessary inaction, are gifted with a very small share of vital powers; we shall see that nearly the whole of that living energy, which is destined, in the sequel, to animate all the systems of the body, is, in the fœtal state, concentrated upon those which are concerned in building up the various parts; and consequently that the functions of nutrition and growth possess, at this age, an energy vastly superior to that of any others.

We may refer the reader to a great number of works on the subjects of the preceding article. In the eighth volume of the *Elementa Physiologie*, Haller has displayed his usual erudition and judgment in a complete collection of all the facts ascertained previously to his time. Dr. Hunter's *Anatomia uteri humani gravidi*, folio, and Soemmerring's *Icones embryonum humanorum*, folio, 1799, contain a perfect series of representations of the human ovum; and its contents from the earliest time to its maturity. Dr. Hunter's Anatomical description of the human gravid uterus and its contents, published after his death by Dr. Baillie, 4to. 1794, is a clear and plain description of the subject. We may mention further, Wrisberg *descript. anat. embryonis, observationibus illustr.* 4to. Gött. 1764, or, in the third volume of Sandifort's *Thesaurus*; also, his remarks on the structure of the ovum in the *Göttingen Commentaries for 1773 and 1783*. Roderer *De pondere & longitudine infantum recens natorum in the Göttingen Commentaries for 1753*; and Wrisberg *de vita fœtuum humanorum* *dijudicanda*,

canda, in the same work for 1773. Autenrieth *supplementa ad historiam embryonis humani*, Tubingen, 1797, 4to.

On the comparison of the structure of the fœtus and adult, see C. I. Trew de differentiis hominis nati et non nati, Altdorf, 1736. I. G. Roderer de fœtu perfecto, Strasburg, 1750. Portal in the Mem. de l'Acad. des Sciences de Paris 1770. A. and F. Roefslein de differentiis inter fœtum et adultum, 4to. Strasburg, 1783. On the nutrition of the fœtus; see Lévillé sur la nutrition du fœtus considéré dans les mammifères & les oiseaux. Paris an. 7. & Lobstein dissertation sur la nutrition du fœtus, Strasburg, 4to-1802. The most complete book on the whole of the subject, that is, the structure and development of the ovum, and the anatomical peculiarities of the fœtus, is F. G. Danz Grundriß der Zergliederungskunde des ungeborenen Kindes in den verschiedenen Zeiten der Schwangerschaft. 2 vols. 8vo. 1793, which contains most abundant references to all the sources of information on every part of the subject.

EMBRYO, in *Vegetable Physiology*, εμβρυον, a fœtus, or infant, the CORCULUM of Linnæus, under which term we have already mentioned it, is the most essential part of a perfect seed. When sexual impregnation has not taken place, this organ is defective, however perfect all the other parts of a seed may be, as in the *Cycas revoluta* which bore fruit at the bishop of Winchester's, and is described and figured in the Transactions of the Linnæan Society, v. 6. 312. t. 29, 30. Here every part of the fruit and seed was apparently in the highest perfection, except that a small cavity was only found in the place of the embryo, a defect doubtless to be attributed to the absence of a male plant of the same species. The same has been observed in cucumbers and melons, whose fruits are not the worse in flavour on account of such a deficiency, though dates, when unimpregnated, are known to be much inferior in quality. The embryo or corculum is very conspicuous in the walnut, the garden bean, pea, lupine, &c. In a very poisonous plant, the *Jatropha Curcas*, figured in Gærtner, t. 108. f. 1. this author mentions as a remark of Mr. Boyle, that the nucleus or albuminous part of the seed may be eaten with impunity, if the embryo and cotyledons, or rather perhaps plumula, be taken away. This same circumstance was pointed out by the natives of Sierra Leone to Dr. Afzelius and his companion Borone. The internal structure of the embryo, before it begins to vegetate, is observed by Gærtner to be remarkably simple, consisting of an uniform medullary substance, enclosed in its appropriate bark or skin. When the vital principle is excited to action, vessels are formed, and parts developed, which seemed not previously to exist, as in the egg of a bird. The embryo is generally situated within the substance of the seed, but not always, being entirely external to the body of the seed, though within the skin, in the natural family of grasses or corn. In umbelliferous plants it occupies the very centre of the seed, and in that family its position is reversed; whereas in compound or syngenesious flowers, though equally central, it is erect with regard to the base or insertion of the seed. In the date and some other palms the embryo is lateral and horizontal; while in the cocoa-nut and others it is erect, in the centre of the base of a large albumen. Its direction is either straight, curved, or even spiral. Its form is most simple in plants that have only one cotyledon, or rather no proper cotyledon at all. S.

EMBRYO-WORMS. It is a matter of no small curiosity, to observe the arrangement of the multitudes of the embryo-worms, as they are lodged in the bodies of the viviparous two-winged flies.

An accurate dissection of one these little animals, shews:

very plainly the parts where the embryo-worms are inclosed. This dissection is easily made with a pair of fine pointed scissars, taking off the whole upper shell of the body from the lower; and that part which covers the belly may be turned back upon the corcelet, without disturbing the internal parts by the operation; and the form and arrangement of the parts which contain the embryo-worms in their, will be found very different from that of those which contain the eggs in the common flies. Baker on the Microscope, p. 115. 416. 417. 428. 430.

EMBRYOPTERIS, in *Botany*, from εμβρυον, an embryo, and πτερον, a wing, as appears from an examination of Gærtner's figure; though, from the construction of the word, it seems to be derived from πτερον, a fern, or brake. Hence this name, as it at present stands, is liable to a double objection, as being compounded of one previously established, *Pteris*, and still more as conveying a false idea of its own application. *Embryopterum* would have been correct and unexceptionable, and we should without scruple have adopted such an alteration; but the name is altogether superfluous, the plant in question being a *Diospyros*, under which head its generic character may be seen. We have, therefore, here only to add to that list of species the following.

*Diospyros glutinifera*, Roxb. MSS. (*Embryopteris peregrina*; Gærtner v. 1. 145. t. 29. f. 2. E. glutinifera; Roxb. Coromand. v. 1. 50. t. 70.) Stamens numerous. Leaves oblong, palish beneath. Seeds eight or ten. This is a middle-sized evergreen tree, growing in the moist cool valleys among the mountains of the northern Circars, flowering in March and April. The natives call it Tumika, and eat the fruit, which Dr. Roxburgh describes as strongly astringent, and not palatable. The Malays name it Mangostan-utan, and the Dutch Lym-appel. The wood is of an indifferent quality, and not much used. The branches are smooth. Leaves alternate, stalked, oblong, sometimes inclining to elliptic, and occasionally a little heart-shaped at the base; entire, smooth, palish beneath. Flowers white; the males in small axillary clusters; females on a separate tree, solitary and larger. Berry globular, about two inches in diameter, of a rusty yellow, and covered with a rusty farina when ripe. Gærtner mistook the top of the fruit for the base, and hence erroneously describes the calyx as superior. He also mistook the radicle of the embryo for a simple cotyledon, but his profound knowledge led him to suspect that a cavity in the other extremity might be the real seat of the embryo, and that the circumambient substance was consequently a vitellus. We presume this cavity to have arisen in the plumula, from a shrinking of the parts, after the vital principle was extinct, his specimen being an old one, and therefore his suspicion was, so far, well founded. He describes the albumen as gelatinous in its centre, and dissolving in water, to which Dr. Roxburgh's specific name, and the Dutch appellation, both seem to allude. S.

EMBRYOTHLASTES, Εμβρυοθλαστες, in *Surgery*, an instrument wherewith to crush the bones of an embryo, or dead child; so as to make it easier of extraction, and prepare it for the embryuleus, to draw it out of the womb.

EMBRYOTO'MIA, from εμβρυον, a fœtus, and τεμνω, to cut, the operation of cutting into the womb, in order to extract the fœtus. See CÆSARIAN Section.

EMBRYULCUS, from εμβρυον, and ελχω, to draw, an instrument used in extracting dead children. See CROTCHET.

EMBS, or EMS, in *Geography*, a small town of Germany, which, till the peace of Lüneville, belonged in part to the landgrave of Hesse Darmstadt, and in part to the

prince of Nassau Dietz, to whom it has been ceded; is chiefly remarkable for five sulphureous baths in its neighbourhood.

EMBS, or *Hohenembs*, a small district of Germany, in the circle of Swabia, south of the county of Bregentz and the lake of Constance, about 10 miles long and 5 broad, erected into a county by Charles V.

EMDEN, or EMBDEN, a town of the kingdom of Holland, capital of the department or province of East Friesland, which, till the year 1807, belonged to Prussia, to the sovereign of which it had been sold by the United Provinces of the Netherlands, in 1744. It is situated on the Ems, not far from the sea, and near the lake Dollart; 30 miles N.E. of Groningen. N. lat.  $53^{\circ} 20'$ . The harbour is commodious; it holds 400 vessels.

Emden had gained considerable commercial importance, from having been declared a free-port by the king of Prussia, in 1751. Its situation was extremely convenient for the Dutch, to carry on their commerce with the greatest security in time of war; particularly during the late wars between England and France, when the Texel was blockaded by the English. Goods used to be forwarded, on the river Ems, to within a short distance of Munster in Westphalia; from which city they were conveyed by land-carriage to the interior of the continent, to Switzerland, and Italy. In the year 1781, the number of ships cleared outwards was 1025, inwards 1004; but in 1799, there entered at Emden inwards 3402 vessels, and 2151 failed outwards. In 1784, Emden had 273 vessels of the tonnage of 38,578 tons, besides 43 vessels for the herring fishery; in 1804, the number of ships employed in the carrying trade only, belonging to Emden, exceeded 500.

The population of Emden, in the year 1785, amounted to 7968 individuals, without the garrison: in 1802, Emden counted 10,400 inhabitants. The herring fishery produced annually near 1000 tons of herrings. It employed 60 boats, and a great many hands among the lower orders of the people.

EMEGIAGEN, a town and fortress of Africa, in the empire of Morocco.

EMENDALS, an old term still used in the accounts of the Inner Temple; where, so much in emendals at the foot of an account, on its balance, signifies so much in the bank, or stock of the house, for reparation of losses, and other occasions.

EMENDATIO *Panis & Cerevisia*, the assize of bread and beer; or the power of supervising and correcting the weights and measures belonging to them. See ASSIZE.

EMERALD. Of this mineral there are two distinct varieties: the true emerald, and the beryl or aquamarine, both of which we shall proceed to describe.

*True Emerald.*—Emeraude Verte, *Fr.* Schmaragd, *Germ.*

The colour of emerald is pure prismatic green, of various degrees of intensity; but the deep-coloured varieties pass occasionally into grass and verdegris-green, and the lighter ones into greenish-white. The only natural state in which it has been hitherto met with is crystallized. Its primitive form is a regular hexahedral prism; sometimes the lateral edges are replaced by secondary planes, forming a dodecahedral prism; or, the solid angles are replaced by small triangular facets; or, the terminal edges are bevelled, sometimes very slightly, and sometimes so deeply as to present the appearance of terminal truncated pyramids. The length of the prisms seldom greatly exceeds their diameter. The crystals are middle-sized and small, rarely large: they are generally implanted, and sometimes imbedded, and al-

ways occur in clusters. The internal lustre is vitreous and shining; the fracture is small and imperfectly conchoidal, passing into obscurely foliated. It is transparent or translucent, and exhibits a double refraction. Its hardness is somewhat superior to that of quartz. Sp. gr. 2.72 to 2.77.

It is fusible *per se* before the blow-pipe, but with difficulty, into a semi-opaque whitish glass. With borax it melts easily, and without effervescence. Its constituent parts, according to Vauquelin and Klaproth, are as follows:

	Vauq.	Klapr.
Silex	64.50	69.11
Alumine	16.	15.
Glucine	13.	12.5
Lime	1.6	0.25
Oxyd of chrome	3.25	0.25
Oxyd of iron	0.	1.
Water	2.	0.
	100.35	98.

It is at present found only in Peru, in the valley of Tunia or Tomana, between the mountains of New Granada and Popayan; and near Puerto Viejo, in the district of Manta, in the same province. It is said to occur in veins, passing through argillaceous schistus, and other primitive rocks, and is accompanied by quartz, feldspar, black schorl, mica, calcareous spar, and iron pyrites.

Emerald is reckoned among the gems, and when of a fine colour, and without flaws, is highly esteemed. The most magnificent specimen known of this mineral was presented to the church of Loretto, by one of the Spanish kings: it consisted of a mass of white quartz, thickly implanted with emeralds, more than an inch in diameter.

The emerald is supposed by Dutens and others to have been unknown to the ancients; and it is certain, that several of their descriptions of the smaragdus are not at all correspondent, except in colour, to the modern emerald. But among the twelve kinds of smaragdus, or rather pseudo-smaragdus, enumerated by Pliny, one of them, and that the most valued, appears to be the real emerald. With regard to its colour, this naturalist says, "Nihil omnino viridius comparatum illis viret." He ranks it, in estimation, immediately after the diamond and pearl; and adds, that so pleasing was its tone of colour, that by common consent the engraver was ordered to spare it: "Quapropter decreto hominum iis parcitur, scalpi vetitis." The emeralds of the ancients were procured from Ethiopia; but these mines have now been for many ages forgotten and neglected; nor is it certain that any except the Peruvian emeralds are now extant. The only one that may with any probability be referred to an African origin, is that with which pope Julius II. adorned the papal tiara: for as this sovereign died in 1513, and the enterprize of Pizarro against Peru did not take place till 1545, it is not unreasonable to conclude that the emerald in question is not an American one. There are two specimens, which formerly obtained great estimation as invaluable Ethiopian emeralds, which the superior accuracy of modern knowledge has stripped of their value, both in the eyes of the naturalist and of the jeweller. The one is a tabular mass, of the weight of 28 lbs. now in the abbey of Reichenau, and which formerly belonged to Charlemagne; this Mr. Coxe has ascertained to be green fluor. The other is the "Sacro cattino de Smeraldo orientale," which was deposited in the treasury of Genoa, and was not allowed to be seen except in consequence of an order from the senate: in this the acute eye of M. Condamine

mine detected some air-bubbles, which induced him to consider it as only green glass; and subsequent examination has fully confirmed his suspicion.

*Beryl, or Aquamarine*—Emeraude verte bleuatre, Hauy. Eder beril, Wern. Its colour is mountain-green, passing into whitish-green, yellowish-green, wine-yellow, and honey-yellow, or blueish-green, passing into small and sky-blue. Its colours are almost always pale; and when two exist in the same crystal, they are generally arranged in alternate layers. The primitive form and varieties of crystallization are the same as those belonging to the true emerald; but the actual and proportional length of the prisms is much greater. The lateral planes of the crystal are striated longitudinally, so as sometimes to give the prism a cylindrical appearance. The joints perpendicular to the axis are generally very distinct, and most commonly are plane surfaces; but sometimes, like those of articulated basalt, they are formed by a convex protuberance let into a cup-shaped concavity. Another singular accident to which this mineral is subject is, that a prism, which at its lower end is solid, terminates occasionally in a brush-like extremity, composed of numerous small prisms. Sometimes a joint is so disposed, that it is no longer perpendicular to the axis of the prism; in consequence of which, an elbow is produced, as if the prism had been broken across, and the pieces ill cemented together again. Sometimes, again, the axis of the prism is perforated. The size of the crystals varies from capillary to 18 inches long by 2 or 3 in diameter. Its external lustre is shining and glistening; internally, it is brilliant and vitreous. The cross fracture is small, and imperfectly conchoidal; the longitudinal fracture is foliated. It is commonly transparent, passing into translucent; its hardness is nearly the same as that of the emerald. It is electric by friction, and often phosphorescent. Sp. gr. 2.68 to 2.72.

According to the analyses of Vauquelin and Rose, it is composed of,

	Vauq.	Rose.
Silex	68.	69.
Alumine	15.	14.
Glycine	14.	14.
Lime	2.	0.
Oxyd of iron	1.	1.
	100.	98.

Beryl occurs imbedded in primitive rocks, also in veins accompanied by quartz, felspar, fluor spar, garnet, mica, and topaz. It is found in Brazil, in Saxony, in the south of France, near the village of Barat, whence very large but ill-coloured crystals have been procured, and occasionally in the highest mountains of Aberdeenshire. But the finest specimens of all come from Siberia, and are found chiefly in three places of this vast country.

First, in the Uralian mountains, about 25 leagues to the north of Ekaterinbourg. The specimens that come from this mine are of a small size, but a very good colour.

Secondly, in the Altaic mountains, between the Ob and the Irtysh. The crystals from this mine are large, and of a greenish-blue colour, but coarse, and mixed with quartz.

Thirdly, in the granitic mountain of Odon Tchelon, in Daouria. This is by far the most interesting and the richest mine. There are in fact three different mines at different heights on this mountain, from which beryls are procured: that situated the lowest is in a mass of semi-decomposed granite, mixed with ferruginous clay and nodules of Wolf-ram; in this there are irregularly disseminated minute

prisms of beryl, rarely exceeding an inch in length, and of a greenish-yellow colour. About 800 yards above this mine is an irregular vein of micaceous clay, from which are procured the most valuable crystals; their colour is a pure pale green, and their dimensions not very unfrequently amount to seven or eight inches in length by two in diameter. At the very summit of the mountain is situated the third mine, in a vein of white indurated clay, mixed with arsenical pyrites: the beryls that it yields are generally of a greenish-blue colour, but sometimes of a pure but pale sky-blue, and very transparent.

Beryl is ranked by courtesy among the gems, but its value is greatly inferior to that of the emerald.

EMERALD, *Oriental*, is a greenish variety of sapphire.

EMERALD, *Counterfeit*. The manner of making counterfeit emeralds in paste is this: take crystal prepared, two ounces; common-minium, or red lead, four ounces; mix these well together, then add of good verdegris two penny-weights, and crocus martis made with vinegar, eight grams. Mix all these well together, and set the whole in the hottest part of a potter's furnace, as long as the fire lasts. It must be put in a strong crucible, and covered with a lute. When it is cold take off the lute, and, if it is baked enough, it will be clear to the bottom; otherwise relute the pot, and put it into the furnace again. Twenty-four hours commonly are sufficient for making this; sometimes it requires a little more. The paste, thus made, is harder than ordinary, and is of a fine colour, and capable of a good polish. Neri's Art of Glass, p. 128.

If the paste be desired of a very deep emerald colour, take prepared crystal one ounce; red-lead, six ounces and a half; of verdegris, three penny-weights and thirteen grains; and of crocus martis, made with vinegar, ten grains. This requires a longer baking than the other, and is less hard, though of a deeper colour.

The proportions of these ingredients may be varied at pleasure, and the colour be made of all degrees of deepness; but the more lead is added, the more baking is required, and, after all, the paste will be so much the softer.

EMERALD *Colour, in the Glass Trade*. The way of giving this beautiful dye to glass is this: in the pots of melted metal, made of pulverine, and without manganese, when the matter is well purified, put a little crocus martis calcined with vinegar. About three ounces of this crocus is enough for a hundred weight of glass; let it stand till thoroughly mixed, then put into every hundred weight of metal two pounds of calcined brass; this must be added at six different times, letting the metal stand two hours every time. When this is all in, make a proof of the metal; and if it has any blueishness, add more crocus martis, a small quantity at a time. When the whole is of a fine leek-green, let it stand twenty-four hours to mix thoroughly, and then work it. Neri's Art of Glass, p. 51.

EMERALD, or *Emerald*, in *Heraldry*, is used in lieu of vert, or green, in blazoning the arms of dukes, earls, &c.

EMERGENI YEAR, in *Chronology*, is the epocha, or date, whence we begin to account our time.

Our emergent year is sometimes the year of the creation; the Jews use that of the deluge, or the Exodus, &c. The emergent year of the Greeks was the establishment, or at least restoration, of the Olympic games by Iphitus. The Romans accounted their years from the building of the city, *AB U. C.* that is, *AB URBE CONDITA*. See *EPOCHA*.

EMERITA AUGUSTA, in *Ancient Geography*. See *AUGUSTA* and *MERIDA*.

EMERSA, *FOLIA*, in *Botany*, applies to such leaves of aquatic plants as are raised above the surface of the water, and

and which are usually of a different figure from those that are *immersa*, or sunk under water. See **LEAF**.

**EMERSION**, in *Physics*, the rising of any solid above the surface of a fluid specifically heavier than itself, into which it had been violently immersed, or thrust.

It is one of the known laws of hydrostatics, that a lighter solid, being forced down into a heavier fluid, immediately endeavours to emerge; and that with a force, or moment, equal to the excess of a weight of a quantity of the fluid above that of an equal bulk of the solid.

Thus, if a solid be immersed in a fluid of double its specific gravity, it will emerge again, till half its bulk, or body, be above the surface of the fluid.

**EMERSION**, in *Astronomy*, is when the sun, moon, or other planet, begins to re-appear, after its having been eclipsed, or hid by the interposition of the moon, earth, or other body.

The difference of longitude is sometimes found by observing the immersions and emersions of the first of Jupiter's satellites.

The immersions are observed from the time of Jupiter's being in conjunction with the sun, to his opposition; and the emersions, from the opposition to the conjunction; which two intervals are usually six months a-piece, and divide the year between them.

But when Jupiter is in conjunction with the sun, and fifteen days before and afterwards, there is nothing to be observed; the planet, with his satellites, being then lost in the light of the sun.

**EMERSION** is also used when a star, before hid by the sun, as being too near him, begins to re-appear, and to get out of his rays.

**EMERSION**, *Scruples*, or *Minutes of*, an arch of the moon's orbit, which the moon's centre passes over, from the time she begins to emerge out of the shadow of the earth to the end of the eclipse. See **ECLIPSE**.

**EMERSON**, **WILLIAM**, in *Biography*, an eminent English mathematician, was born in 1701, at Hurworth, a village near Darlington, in the county of Durham. His father kept a school, and was a good mathematical scholar: to him, and to a young clergyman, the subject of this article was chiefly indebted for his early instruction in the different branches of the mathematics. He attempted to keep a school himself, but soon found his temper unfitted for the task; and, on the death of his parents, having come into the possession of a moderate competence, he devoted himself to a life of studious retirement, where he composed a great number of treatises, by which his name has been long known to all lovers of science; and from the profits of which he redeemed his little patrimony from some incumbrances which he found on it. He enjoyed a good state of health till nearly the close of his life, when he had frequent and very severe attacks of the stone; a disease to which, in the year 1782, he fell a victim, when he had attained to the 81st year of his age. Mr. Emerson was singular in his behaviour, dress, and conversation. His manners were rough, coarse, and often very disagreeable. In conversation, he was positive, dogmatical, and impatient of contradiction. His relaxation from study was sometimes working in the fields, and sometimes the amusement of fishing, to which he was much attached. When he had any treatise for publication, he always went to London, to attend to the printing himself. He was an able mathematician; but his style as a writer is not adapted to smooth the path of science for beginners. His works, which are very numerous, are now chiefly superseded by other and more popular writers, who

have had the better art of facilitating the studies of young persons, by a more agreeable style, and an easier method of demonstration. His "Treatise of Mechanics" is that which is now best known, and to which reference is more frequently made than to any of his other works.

**EMERSTORFF**, in *Geography*, a town of Germany, in the archduchy of Austria, seated on the Danube; 6 miles above Crems.

**EMERUS**, in *Botany*. See **CORONILLA**, species 1.

**EMERY**, *Schmiengel*; Wern. in *Mineralogy*. Its colour is greyish-black or blueish-grey. It occurs massive and disseminated: when in mass, it is generally encrusted with magnetic iron ore, pyrites, and mica; the latter substance frequently penetrates the whole mass, giving it, when broken, a silvery appearance. It possesses a glistening or glimmering lustre. Its fracture is fine-grained uneven, passing into splintery. Its hardness is about equal to Adamantine spar, cutting flint and rock-crystal with great ease. It is heavy, and not very easily frangible. When most free from iron, it consists, according to Tennant, of

Silex	314
Alumine	92.
Iron	4.6
	100.

When highly impregnated with iron, this ingredient amounts to about 36 per cent.

Emery is procured from the islands of the Archipelago, especially from Naxos; also from the neighbourhood of Alocer, in Extremadura, in Spain. Much of the emery used in France is imported from the islands of Guernsey and Jersey, in the British channel. It is also found at Ochsenkopf, in Saxony, in beds of talc and steatite.

This mineral is largely used for cutting and polishing, by lapidaries and workers in glass and metal. The mode of its preparation is very simple. Being pulverized in an iron mortar, it is carefully washed over, and thus separated into five or six different degrees of fineness, according to the work in which it is to be employed.

**EMER-YAPAR**, in *Geography*, a town of Asia, in Tibet; 17 miles from Che-tcheou.

**EMESA**, **EMISA**, *Emissa*, or *Emesus*, in *Ancient Geography*, an ancient city of Syria, situated on the eastern bank of the Orontes, between Apamea and Laodicea Cabiosa. During the troubles which agitated Syria, this city was seized by an Arabian, named Sampsiceramus, who, assuming the title of king, held Emesa and its small territory, undisturbed by the Seleucidæ, engaged in more important concerns. He left two sons, Jamblichus and Alexander; the former of whom succeeded his father, and was much attached to the Romans. In the civil wars of Rome, he took part first with Cæsar against Pompey; and afterwards with Antony against Octavianus. After the victory gained by the latter at Actium, Antony, dreading his concurrence with other princes in favour of the conqueror, and upon this suspicion, having got him into his power, caused him to be put to a most cruel death. Upon his death, Antony bestowed the kingdom on his brother Alexander, who, continuing faithful to his benefactor in his greatest distress, was taken prisoner by Octavianus, and not only deprived of his kingdom, but carried in triumph to Rome; and afterwards put to death. His son, Jamblichus II., was favoured by Octavianus, and restored by him to his father's kingdom, after he had remained for some time in a state of exile. He had some successors, who supported the dignity of this small kingdom; but the last of its kings, whose name is recorded

corded in history, was Azizus, who, falling in love with Drusilla, the sister of Agrippa Minor, embraced the Jewish religion, in order to marry that princess. This small kingdom was afterwards, as we may presume, seized by the Arabians; for we find that, some years after, it was possessed by the Iturzans. Emesa was the birth-place of the emperor Heliogabalus; and it was one of the cities in which the Romans planted colonies. It is now called *Homs*; and though formerly a strong and populous city, it is at present only a large ruinous town in the pachalic of Damascus, containing not more than 2000 inhabitants, partly Greeks and partly Mahometans. An aga resides here, who holds, as a sub-renter of the pacha of Damascus, the whole country as far as Palmyra. The pacha himself holds this farm, as an appanage deriving immediately from the sultan. Hama and Marra are held in the same manner; and these three farms pay 400 purses, or 500,000 livres (about 20,000*l.*), but they produce nearly four times that sum. Volney's *Travels in Egypt and Syria*, vol. ii.

EMETICS, in *Medicine*, from ἐμέω, *I vomit*; those substances which excite vomiting, or cause the stomach to reject its contents upwards.

Medicines of this class have been employed, for the purpose of clearing the stomach, from the earliest ages to which any authentic records of practice extend. In the time of Hippocrates, indeed, the use of emetics seems to have been very general, not only as a remedy in diseases of some severity; but as a popular expedient for relieving slight indisposition, especially the occasional derangements of the organs of digestion, brought on by indulgence in eating and drinking. Hippocrates even recommends them to the healthy as a preservative; and he has stated many precepts with respect to the proper times for administering them, in conjunction or alternation with fasting, bathing, exercise, &c. under various circumstances of health and disease. See his treatise on Diet, book iii. and elsewhere. Yet it must be remarked, that the catalogue of emetic substances in the possession of the ancients was very imperfect, in comparison with our own; and consisted either of uncertain and almost inert articles, on the one hand, or of severe and rather unmanageable substances on the other. Hippocrates prescribed powdered hyssop in about a gallon of water, as a vomit for corpulent men, with the addition of a little vinegar and salt; it was to be drunk at first gradually, and afterwards more quickly.

Celsus has likewise detailed a set of rules, relative to the use of emetics, among the means of reducing the habit, if too plethoric. He says, "emetics are more useful in the winter than in the summer, because in that season there is more phlegm, and a greater heaviness in the head. They are of no advantage to those who are slender, or who have a weak stomach; but are useful to plethoric, and bilious people, whether they have suffered from repletion, or have their digestion impaired. For if they have taken more than the digestive power is able to concoct, they ought not to risk the danger of its corrupting; and if it is already corrupted, it is proper to expel it in the most expeditious way possible. Hence, when any person is attacked with bitter eructations, together with pain and weight in the region of the stomach, let him immediately resort to a vomit. It is also proper for those, who have a sense of heat in the breast, a frequent spitting or nausea, or a noise in the ears, or humour in the eyes, or a bitterness in the mouth," &c. "I grant," he observes farther, "that emetics should not be taken for the sake of indulging a luxurious appetite; but that they are advantageous in some forms of disease, I know from experience: I admonish those, however, who wish to enjoy good health and attain old age, not to make a daily

use of them. If any one wishes to vomit after taking food, he should first drink warm water only, if he vomits easily; if with some difficulty, he should add a little salt or honey to the water: but he that intends to vomit in the morning, should drink *mulze* (a mixture of wine and honey,) or eat hyssop, or radish, and then drink warm water, as has been already directed. All the other substances, which the ancient physicians prescribed, are injurious to the stomach. If that organ is weak after the vomit, a little food should be taken, of a proper kind; and if the fauces have been much irritated, three cups of cold water may be drunk. He who has used a vomit, if it were in the morning, ought to take a walk, then anoint, and afterwards sup; but if after supper, he should bathe on the following day, and sweat in the bagnio: he will do well to make the next meal slight, and that of roasted meat, with austere and unmixed wine, stale bread, and food of the driest kind." He concludes with this observation: "he that chuses to vomit twice in the month, will find it more advantageous to do it for two days successively, than if he were to repeat it on the fifteenth day; unless this intermission should occasion a weight at his breast." *De Medicinâ*, lib. i. cap. 3.

These statements shew, that the use of emetics constituted a part of that regimen, among the ancients, in which more of their time was occupied, and more attention bestowed, than the moderns in this country are accustomed to give to the subject. They also resorted to vomiting, as a remedy in fevers, and other diseases. See Celsus, lib. iii. cap. 7. And emetics, as well as purgatives, were employed after the termination of fevers, upon theoretical principles, to evacuate the remainder of the morbid matter, after its virulence was supposed to be subdued by concoction. In the use of purgatives, we find some remains of this theory among the people, as well as among the ignorant part of the profession, even at the present day. Hippocrates seems to have believed, that this remnant of the morbid matter, like a piece of leaven, if retained after the crisis, was the occasion of the return of the disease. "Quæ per morbos post judicationem intus relinquuntur, morborum reversiones faciunt." Aphor. 12. sect. ii.

The direct effect of an emetic is the evacuation of the contents of the stomach. Hence the principal purpose, for which it may be used, would seem to be the removal of morbid or noxious matters from that organ; whether consisting of its own secreted juices, in a diseased condition of indigestible food, either from quantity or quality, of poisons, or of other noxious substances, which may have been swallowed. Hence the vulgar resort to emetics on every occasion of what is popularly called a "foul stomach," or of "bile on the stomach." These conditions are presumed to exist, when such symptoms as the following are present: when there is a want of the usual appetite, or, in addition to that, a loathing of food; or, when, after food, or during the time of its digestion, an uneasy sensation of fullness, weight, and distension is felt in the stomach, especially if accompanied with heartburn, flatulency, and acid or bitter eructations; and to these may be added frequent head-achs, particularly in the morning.

Now, although it cannot be questioned, that the removal of the present contents of the stomach, in such cases, generally affords more or less relief; it is not the less certain, that this relief is seldom very durable; for the noxious matters are more frequently to be considered as the effects, than as the causes of the morbid condition of the stomach: they depend most commonly on the weakness and loss of tone in the muscular fibres of the stomach, and the imperfect secretion of the gastric juice; and these, it is obvious, are not to be cured

by vomiting, though their consequences may be relieved by this for a longer or shorter time. On the contrary, there can be no doubt, that frequent vomiting renders the stomach less able to retain, what is thrown into it, and to weaken its powers of digestion. "They are unhappy," says Dr. Cullen, "who trust to this mode of relief, and have therefore frequent recourse to it; for I am certain, from much experience, that frequent vomiting hurts the tone of the stomach, and often makes the symptoms of indigestion recur more frequently and sooner than they otherwise would have done." *Treatise on the Materia Medica*, vol. ii. p. 465.

The same author remarks, that the effects of vomiting, and the degree of disease that required it, are commonly judged of by the vulgar, and often by physicians, though not always fairly, by the appearance of the matter thrown up. For example, there is commonly thrown up a considerable quantity of viscid mucus; and to this the symptoms of the disease are frequently imputed. "It is, indeed, possible," he adds, "that an unusual accumulation of mucus in the stomach may be the cause of want of appetite, and other symptoms of indigestion, but not always so justly as might be imagined. The mucous follicles of the stomach constantly pour out a considerable quantity of this matter; a considerable quantity is to be found in the stomachs of the most healthy persons: and the experiments of M. Senac shew, that there is always a considerable quantity of it in the mucous follicles, which may very readily be squeezed out very copiously in vomiting. It is not, therefore, to be judged that the quantity, and even a large quantity, thrown up by vomiting, had either previously existed in the cavity of the stomach, or that such a mucus had been the cause of the morbid symptoms, indicating therefore the repetition of vomiting. It has been upon occasions of this practice, that I have known repeated vomiting, not only to give no durable relief, but rather to increase the supposed cause."

The evacuation, however, occasioned by an emetic, is not confined exclusively to the stomach; the upper part of the intestines, namely, the *duodenum*, and even part of the *ilium*, is commonly evacuated at the same time. The peristaltic motion of the alimentary canal may proceed either downwards or upwards; and when the action of any part of it is directed in one way, the next adjoining portion follows in some degree the same direction. Whence, in vomiting, as the peristaltic motion of the stomach is directed upwards, so the motion of the duodenum, is directed in the same way, and it pours its contents into the stomach; from which it will appear that a considerable portion of the upper part of the intestines may be evacuated. The most clear proof of this inverted motion of the duodenum, in vomiting, is, that, especially after repeated vomiting, a quantity of bile is poured into the stomach, and is in consequence thrown out by the mouth. This frequent appearance may depend entirely upon the quantity of bile for the time present in the duodenum; but it probably extends farther. In the action of vomiting, as the contraction of the diaphragm and of the abdominal muscles concurs at the same time, the whole viscera of the abdomen are strongly pressed: this pressure must affect the gall-bladder and the biliary ducts, and occasion them to pour out their contents very largely, which, being thrown into the stomach from the *duodenum*, may be ejected by vomiting. It is commonly supposed, indeed, by the vulgar, that the bile thus thrown up existed previously in the stomach, and in some instances it may have been so: but it is more probable that it had been brought from the *duodenum*, and even from the gall-bladder and biliary ducts in the way just explained. For had the bile been previously lodged in the stomach itself, it

might have appeared in the first vomitings, as well as in the last; but it happens, in almost all instances, that the bile is thrown out by the mouth only after repeated vomitings, and often after repeated straining in the organs employed in that act.

Dr. Cullen attributes some good effect to the pressure on the liver and abdominal viscera, just alluded to, in obviating the stagnations which are liable to occur in the system of the *vena portarum*, and which lay the foundation of obstinate diseases. He affirms, that he knows no means of expediting the circulation in the liver so powerful as that of vomiting. Other writers have expressed an opinion of the advantages derived from this mechanical pressure and conqassation of the viscera of the abdomen, in exciting the mesenteric circulation, as well as that of all the glands, and consequently in favouring and aiding all their secretions. (See Dr. Fothergill, *De emeticorum usu*, &c. Cullen, loc. cit. p. 468.) Dr. Cullen, however, considers the effects of this mechanical compression and motion as most evident in the viscera of the thorax, especially in promoting expectoration: hence the utility of vomiting in catarrhal affections, more particularly the chronic catarrh of old people. He also allows that it may be useful in many cases of pulmonary consumption; but justly adds, that we cannot, either from theory or experience, find any reason to believe that frequent vomiting is adequate to cure that disease.

There is also another indirect action of vomiting, which is beneficial to the system, arising from the sympathy between the stomach and the skin. This sympathetic consent between the vessels of the skin and of the stomach is very great, inasmuch that the several states of each may be communicated to those of the other. Thus, wetting the skin relieves thirst, as was proved by Capt. Bligh and his party; and in the same way the action of an emetic excites particularly the action of the vessels on the surface of the body; and this action is excited by doses of these medicines, which are not sufficient to excite vomiting. Hence most of the substances employed as emetics are capable of exciting perspiration. We are disposed to believe that a similar sympathy, between the stomach and the vessels in the cells of the lungs, is the cause of the utility of vomiting in producing expectoration, rather than the mere mechanical pressure of the lungs.

The action of vomiting, when excited rather briskly, by the general shock or conqassation of the whole frame, affects the nervous system at large as a stimulant. In this way the utility of an emetic, in the commencement of a continued fever, is partly to be accounted for. Dr. Cullen, indeed, attributes the advantages of vomiting in that case to the relaxation of the spasm of the extreme vessels in the skin, according to his theory of fever; and partly, perhaps, the operation may be accounted for in this way: but it is to be remarked, that other expedients, which have nothing in common but the general shock which they occasion to the nervous system, also contribute to cut short or to alleviate fever, under the same circumstances; a brisk purgative, for example, cold affusion, or the shower-bath, &c.

It is also observed by Dr. Fothergill, who ascribes considerable effects to the *stimulant* operation of emetics, that, in spasmodic disorders, and several others of the nervous kind, which seem to arise principally from the torpor and languor of the digestive organs, emetics are often of essential benefit. He mentions CHOREA, or St. Vitus's Dance, certainly not the least obstinate of nervous complaints, as often relieved by emetics.

The same celebrated physician cautions us particularly respecting the administration of emetics to those who are of

## EMETICS.

plethoric habit, or who labour under diseases, in which general or local plethora is present. If the symptoms, in such cases, indicate the propriety of employing emetics, blood-letting ought, in his opinion, to precede their use; for there is danger, left in the temporary convulsion of straining to vomit, the distended vessels should be ruptured, or the blood be carried with too great force, or in too great quantity, to parts where the resistance of the vessels is too weak to withstand it. Thus, if the vessels of the head should give way, a sudden and fatal apoplexy may be brought on; if those of the lungs should be ruptured, a spitting of blood, followed by a slow, but not less fatal consumption, may be induced, or similar mischief may be occasioned in other viscera. (Loc. citat.) In cases, however, in which these plethoric diseases are to be suspected, the prudent practitioner will, even after blood letting, consider emetics as inadmissible, unless the necessity of immediately emptying the stomach of its contents be great and pressing.

The occasion, on which such a necessity is the most obviously paramount to all other considerations, is when poison has been recently swallowed. In this case, the greatest risk is from the operation of this substance on the stomach, and therefore the most expeditious means of inducing vomiting are to be adopted. If the poison be of the vegetable narcotic species, such as opium, it often so completely paralyzes the muscular fibres of the stomach, as that ordinary emetics have no power to excite its action. The white vitriol, or sulphate of zinc, operates in general almost instantaneously, especially if swallowed with a large quantity of water. When this has failed, we have known a few grains of the blue vitriol, or sulphat of copper, dissolved in warm water, given with success, where opium had been swallowed. A strong infusion of ipecacuanha, drank copiously, has sometimes effectually emptied the stomach under similar circumstances.

In a fit of inebriety, when vinous or fermented liquors have been drunk to the extent of inducing a state approximating to apoplexy, the safest, perhaps, and best mode of emptying the poison from the stomach, consists in pouring in warm water as copiously as it can be swallowed; since it at once dilutes the inebriating liquor in the stomach, and therefore diminishes its effects, and urges the stomach to expel it. See DRUNKENNESS.

Although emetics have been found to be beneficial in the early stages of all fevers, as already mentioned, yet we must not here omit to notice their peculiar good effects in the scarlet fever, as observed by Dr. Withering. (See his Treatise on the Scarlet Fever.) This fact, indeed, had been pointed out by Tournefort (in his voyage to the Levant, tom. i.), and other writers; but Dr. Withering recommends vomiting, repeated according to circumstances, as the most essential remedy for this disease. "In the very first attack," he says, "a vomit seldom fails to remove the disease at once. If the poison has begun to exert its effects upon the nervous system, emetics stop its further progress, and the patients quickly recover. If it has proceeded still further, and occasioned that amazing action in the capillaries, which exalts when the scarlet colour of the skin takes place, vomiting never fails to procure a respite to the anxiety, the faintness, and delirium." Dr. Willan also speaks highly of the utility of emetics in scarlet fever, with sore throat, but has not found it necessary to repeat them so often as Dr. Withering advised. Treatise on Cutaneous Diseases, ord. 3.

Emetics are sometimes useful in asthma, and in hooping-cough, probably upon the same principle as in chronic catarrh, before noticed. They have been said also to assist in

forwarding a gall-stone through the ducts into the intestines as well as an urinary calculus from the kidney to the bladder, through the ureter, by the mechanical agitation of the body, which they occasion. But their operation in this way must be very feeble and uncertain, and may do injury, when the calculi are large or angular. Sydenham employed strong emetics as remedies for dropsy; but they generally purged also, to which operation their good effects, when they did prove beneficial, must be the rather attributed.

The catalogue of medicines possessing an emetic power, which were in use among the ancients, although sufficiently ample, contained, as we have already said, substances either of feeble and uncertain action, or of acrid and violent qualities. The hellebore was sometimes fatal. Even Sydenham complained in his time, that an emetic substance, which was "safe, and at the same time effectual," was a desideratum in the *Materia Medica*. His active emetic consisted of the *crocus metallorum*, as it was then termed, or *crocus antimonii*, (a preparation made by deslagrating the sulphurated antimony with an equal weight of nitre,) which being soluble in any acid, was most uncertain in its operation, as it depended upon the quantity of acid with which it met in the stomach. The ipecacuanha root appears to afford that substance to us, which was a desideratum in the time of Sydenham.

We may, with Dr. Fothergill, consider emetics under three heads, the very mild, the moderate, and the strong or drastic; not to mention the irritation of the throat with a feather; the exercise of swinging, sailing, or whirling round certain objects of sight, &c. which are not resorted to as remedies. Among the mildest means of exciting vomiting, is filling the stomach suddenly with a large quantity of liquid; simple warm water is generally sufficient for the purpose; but its operation is aided, when other substances of little power are combined with it: thus, infusions of green tea, of chamomile flowers, the *carduus benedictus*, broths, &c. may be employed for this purpose. Again, when it might not be proper to give an emetic substance, in such a dose as might of itself excite vomiting, by the assistance of copious draughts of warm water, small doses may serve the purpose of evacuating the stomach, and even of obtaining the other effects to be derived from vomiting.

The moderately active emetic substances are those which are at present in general use; namely, the ipecacuanha, and the tartar emetic, or tartrate of antimony, in small doses; and also some other substances, when much diluted with warm water, which might be of too inflammatory a nature if given alone, in such quantity as to produce vomiting; such are, an infusion of the root of horse-radish, or a tea-spoonful of mustard as prepared for the table, some preparations of the squill, the asarum, &c. The ipecacuanha was first introduced as a remedy for dysentery; but it is now ascertained that its utility in that disease depends upon its purgative quality.

The metallic salts formed with sulphuric acid are active emetics, and may be arranged in the strongest or drastic class. The least violent of these is the white vitriol, or sulphate of zinc, which has been chiefly employed on account of the suddenness of its operation, when poisonous matters have been taken into the stomach: but, in order to render its effects certain, the dose must generally be large, and if it is not thrown out again immediately, it is apt to continue a disagreeable nausea, or even a vomiting, longer than is necessary. Dr. Cullen says, "I find that the purpose of this medicine (that is, a sudden vomiting,) may commonly be obtained by employing a large dose of ipecacuanha, either in powder or in the wine; and by following this soon after with a large

draught of warm water impregnated with chamomile, or rather with what is more at hand, a tea-spoonful of table-mustard; the business may be commonly very effectually executed."

The preparations of mercury are seldom employed as emetics. The sulphat, or turpeth mineral, has been chiefly used, but its operation is violent.

Dr. Darwin observes, that "the quantity of the dose of an emetic is not of so great consequence as of other medicines, as the greatest part of it is rejected with the first effort. All emetics are said to act with greater certainty when given in a morning, if an opiate had been given the night before. For the sensorial power of irritation of the stomach had thus been in some measure previously exhausted by the stimulus of the opium, which thus facilitates the action of the emetic; and which, when the dose of opium has been large, is frequently followed on the next day by spontaneous sickness and vomitings, as after violent intoxication." *Zoonomia*, part 3. art. v. 2. I.

**EMETIC POWDER**, called also *powder of Algaroth*, from the name of its author, is a precipitate of antimony; or butter of antimony sweetened and softened by repeated lotions. See **ANTIMONY**.

**EMETIC TARTAR**, is now called *Antimonium Tartarifatum*. See **ANTIMONY**.

**EMETIC WINE**, *vinum antimonii*, is only white wine, wherein is infused some glass of antimony. See **ANTIMONY**.

Small doses of emetic wine have been recommended as deobstruent and sudorific in slow fevers, in many chronic diseases, and especially in an obstinate rheumatism. See *Medic. Ess. Edinb. abr. vol. i. p. 170.* and *Huxham, Obs. de Aere & Morb. epidem.*

**EMETZ**, in *Geography*, a town of Russian Siberia, in the government of Tobolsk; 28 miles W. of Ilichim.

**EMEU**, in *Ornithology*, the common name of the Cassowary, a large bird of the ostrich kind.

**EMILE**, in *Geography*, a small town of France, in the department of the Seine and Oise, chief place of a canton in the district of Pontoise, with a population of 1800 individuals. The canton contains 20 communes and 13,843 inhabitants, on a territorial extent of 127½ kilometres.

**EMILI, PAUL**, in *Biography*, a modern historian, was born at Verona. In Italy he obtained a great character, and was brought into France by the cardinal de Bourbon, in 1487, who patronized him till his death. After this he was obliged to teach the languages for a subsistence. He undertook to write the history of France, for which he was rewarded with a canonry in the cathedral of Notre Dame. This history he brought down, in ten books, from Pharamond to the 5th year of Charles VIII.; it was published at different times; and likewise altogether at Paris in the year 1539, and has been several times re-printed and translated into foreign languages. His style is pure, but sometimes too concise, and even bordering on the obscure; he is nevertheless to be regarded as the first writer who gave to French history a just form and method. He died at Paris in the year 1529, leaving behind him a very excellent character: his morals were as pure, as the language adopted in his works was chaste and elegant. Bayle.

**EMILION, SAINT**, in *Geography*, a small town of France, in the department of the Gironde, near the river Dordogne; six miles E. of Libourne, remarkable for the excellent wine which grows in its neighbourhood.

**EMILIUS, ANTHONY**, in *Biography*, professor of history in the university of Utrecht; was born Dec. 20th, 1589, at Aix la Chapelle, where his father had retired for the sake of

his religion. He received the early parts of his education in his native country, and finished his classical studies at Dort, under the famous Gerard John Vossius: he then went to Leyden and other universities, and spent some years in foreign travel. On his return to his native country he succeeded Vossius as rector of the college of Dort, and some time after he went to Utrecht to exercise the same office, where he was afterwards elected to the professorship of history, an office in which he continued till his death, November 10th, 1660. His lectures, for more than twenty-six years, were taken from the annals of Tacitus. He published, about the year 1651, a collection of Latin speeches and poems. Bayle.

**EMILLAGUE**, in *Geography*, one of the Pelew islands.

**EMINENCE**, a little hillock, or ascent, above the level of the adjoining champain.

**EMINENCE** is also a title of honour given to cardinals.

The decree of the pope, whereby it is appointed, that the cardinals should be addressed under the quality of eminence, bears date the 10th of January, 1630. They then laid aside the titles of *illustrissimi*, and *reverendissimi*, which they had before.

The grand master of Malta is likewise addressed under the quality of eminence.

The popes John VIII. and Gregory VII. gave the same title to the kings of France. The emperors have likewise borne it.

*Eminentissimus*, the superlative of eminent, hath of late been attributed to the cardinals.

**EMINENTIAL EQUATION** is used by some algebraists in the investigation of the areas of curvilinear figures; for a sort of artificial equation, containing another equation eminently. *Hayes Flux. p. 97.*

**EMINENTLY, EMINENTER**, in the *Schools*, is used in contradistinction to *formally*, and in the same sense with *virtually, viz.* to denote that a thing possesses, or contains, any other in a more perfect or higher manner than is required to a formal possession thereof.

Thus an angel is said to have prudence eminently; as he has it in a higher and more perfect degree than it is in man, in whom it is formally.

For one thing to contain another eminently, there are usually required two conditions. 1. That the containing be of a more excellent nature than the contained. 2. That the less excellent be some way contained in the more excellent; *viz.* either as in its productive cause, or by some similitude, or as to the manner and order of acting, &c.

**EMIR**, a title of dignity, or quality, among the Turks, and Saracens, attributed to such as are relations or descendants of their great prophet Mahomet.

The word is Arabic, and literally signifies *prince*. It is formed of the verb **אמר**, *amar*, which is originally Hebrew; and in both these languages signifies *to say*, and *to command*. This is a title given to all the nobility of the first rank in the empire of the Mogul and in Tartary. The plural of this term is "Omra."

The emirs are held in high veneration, and have alone the privilege of wearing a green turban. On the borders of the Holy Land there are several emirs sovereign princes; as the emir of Gaza, and the emir of Terabea, over whom the grand signior has but little authority. The title emir, at first, was only given to the caliphs: in Persia they were also called *emir zadeb, q. d. prince's son*; whence by abbreviation of emir, they formed *mir*; and of *emir zadeb, mirza*. In after times, when the caliphs had assumed the title of sultans, that of emir remained to their children, as that of Cæsar did among the Romans.

At length, the same title of emir came to be attributed

to all who were judged to descend from Mahomet by his daughter Fatimah, and who wear the green turban.

EMIR is also a title, which being joined to some other word, frequently denotes an office or employ; as the *emir al omera*, commander of commanders, who, in the time of the caliphs, was chief of the councils and armies.

The appellation emir is also applied by the Turks to all viziers and bashaws, or governors of provinces. (See BASHAW, &c.) Add, that *emir akhor*, vulgarly *imrahor*, is master of the horse to the grand seignior.

*Emir alem*, vulgarly *miralem*, standard-bearer and director of all the standards of the empire.

*Emir bazar*, the provost, or superintendant of the markets, who regulates the prices of provisions.

The *emir bagge*, or *badj*, denoting pilgrimage, or prince conductor of the pilgrims of Egypt to Mecca, is bashaw, or pacha of Damascus. See CARAVAN and DAMASCUS.

*Emir al moslein*, or *emir al moumenin*, i. e. commander of the faithful, or the believers, was a title assumed by the Almoravides and Almohades, who reigned in Africa and Spain.

EMIR-BACHA, in *Geography*, a town of Asiatic Turkey, in the province of Natolia; 80 miles W. of Tocat.

EMISSARIA, in *Anatomy*, are the veins which pass into the skull from the external parts of the head, and terminate in the sinuses of the dura mater. These openings are described in the article CRANIUM. The veins are sometimes called after Santorini, an Italian anatomist. See VEINS.

EMISSARIUM, in *Antiquity*, a sluice, or drain, to draw off the water used in watering gardens, fields, &c.

EMISSARY, formed of *e* and *mitto*, *q. d.* I send out, a trusty, dextrous, able person, sent secretly, to sound the sentiments and views of another, to make him some proposal or overture; or to spread reports, watch the actions, motions, and countenance of a contrary party or person, in order to make advantage of them all. See SPY.

The leaders of parties have abundance of emissaries employed in their service, who inform them of what passes every where, that they may take their measures accordingly.

EMISSION, the act of throwing, or driving a thing, particularly a fluid, from within, outwards. The ancients took vision to be performed by the emission of visual rays from the eye.

But the term emission is chiefly applied among us to the expulsion or ejaculation of the seed.

EMISSION of Heat.—All the heat we experience in the world is derived from three sources; viz. from the sun; from compression, which comprehends collision and friction; and lastly, from the decomposition and composition of bodies.

It is hardly to be doubted, that the emanation of heat from the sun, like the emanation of light from the same source, is not constantly the same; and it is recorded in history, that at certain times the light of the sun has been observed to be pale, or less bright than usual; and had the thermometer been in use amongst the ancients, it would probably have been observed that the dimness of light was accompanied with a proportionate diminution of the usual heat; for these alterations, as far as we can conjecture, seem to depend upon the size of the spots which cover the surface of the sun at different and uncertain times.

The direct rays of the sun on the same part of the surface of the earth, are more or less hot according to the time of the year, the clearness of the atmosphere, the state of the wind, and the colour or other quality of the spot upon which they fall. On this island, in the summer season, the direct rays of the sun seldom raise the thermometer to 110°. But in other climates, especially within the tropics, they

raise it much higher; sometimes as high as 150°. We must not, however, believe the strange accounts of their melting lead or firing gun-powder; for those rays cannot produce any such effect, provided they are not concentrated, or assisted, by artificial means.

It is not on account of the sun's being nearer or farther from us, that we receive much more heat at one time of the year than at another; for the difference of its distance is too small to produce any sensible effect; nor is it owing to the sun's emitting more caloric rays at one time of the year than at another. But we receive more heat in summer than in winter, 1st, because the sun being nearer to our vertex, or to the zenith, in the former, than in the latter season, its rays have a shorter way to pass through the atmosphere, and are of course less obstructed by it. And the same cause renders the sun's rays hotter about the middle, than at the commencement or the close of the same day: 2dly, we receive more heat when the sun is higher, because in that case a greater quantity of its rays fall upon any given portion of the surface of the earth; than when it is lower, and its rays come in a direction more oblique; and, 3dly, because in the summer season the sun remains longer above the horizon than in winter.

With respect to the cause of the emission of heat from the body of the sun, we cannot pretend to have the least knowledge. It is generally supposed that the sun is a body of fire; but it is impossible to say, whether it is an aggregate of caloric, independent of other matter, or a compound body undergoing a gradual decomposition. It was, some time ago, also supposed, that the sun emitted only rays of light, and that the action of those rays upon terrestrial bodies, extricated the heat from the latter. But the recent discovery (made by Dr. Herschell,) of the caloric rays of the sun suffering a different refraction from that of its luminous rays, besides other considerations, renders this supposition vain. Excepting from the sun, no sensible degree of heat is derived from the moon or from any other celestial object.

The immediate production of heat by the other means that have been mentioned above, viz. by compression, collision, friction, composition and decomposition of bodies, arises either from the caloric being squeezed out of a body, like water out of a sponge; or from an alteration of the capacities of bodies for containing heat. We shall endeavour to illustrate these processes.

I. Experiments shew, that when a certain substance is compressed into a narrower space, a quantity of heat comes out of it, and is communicated to the surrounding bodies. On the contrary, when a certain substance is expanded into a larger space, it absorbs a quantity of heat from the surrounding bodies; for these bodies are cooled in consequence of it. Thus, if you wet your hand, and then expose it to the ambient air, the water, in the act of expanding itself into the form of vapour, absorbs a quantity of heat from the hand, which is thereby sensibly cooled. If, by means of a condensing engine, air is compressed in a proper vessel, heat is extricated from it; and if the operation be performed quickly, a quantity of heat will be emitted, which is sufficient to set fire to tinder, and other light combustible bodies. When the steam of water is condensed, heat is deposited by it upon those bodies which are in contact with it.

Wood rubbed against wood, or against any hard body; metal rubbed against metal, or against any other hard body; in short, solid bodies rubbed or knocked against each other, are thereby heated, often so far as to become red-hot.

By this means, heat may be produced where there is no oxygen, so that in those cases it cannot be derived from the

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decomposition of that air. This has made some persons suspect that heat is not the effect of a peculiar substance called *caloric*; but that it is only a peculiar movement of the particles of bodies. The most striking experiments relative to this subject were made by count Rumford (Phil. Trans. for 1798. p. 1.) He took a cannon, not yet bored, having a projection of two feet beyond its muzzle, a part which is usually cast with the piece, in order to insure the solidity of the metal throughout, by the pressure which its weight occasions. This piece was reduced to the form of a cylinder, joined to the cannon by a smaller neck, and a large hole was bored in it; the whole cannon was then made to revolve on its axis by means of the force of horses, while a blunt steel borer was pressed against the bottom of the hollow cylinder, by a force equal to about 10,000lb. avoirdupois; the surface of contact of the borer with the bottom of the cylinder being about two square inches. This apparatus was wrapped up in flannel, when its temperature was about 65°. In half an hour, when the cylinder had made 960 turns, the horses being stopped, a mercurial thermometer was introduced into a perforation in the bottom of the cylinder, extending from the side to the axis, and it stood at 130°, which count Rumford considers as expressing very nearly the mean temperature of the cylinder. The dust or scales, abraded by the borer, weighed only 837 grains, or about  $\frac{1}{650}$ th of the whole weight of the cylinder. In another experiment, the cylinder was surrounded by a tight deal box, fitted with collars of leather, so as to allow it to revolve freely, and the interval between the cylinder and the box was filled with 19 pounds of cold water, which was excluded from the bore of the cylinder, by oiled leathers fixed on the borer; and after two hours and a half the water was made to boil. Hence count Rumford calculates that the heat produced in this manner, by the operation of friction, was equal to that of nine wax candles, each three quarters of an inch in diameter, continuing to burn for the same time.

Reasoning upon these results, count Rumford thinks, that the heat, thus produced, cannot be extricated from the bodies concerned; and he is led to ask "What is heat?—Is there any such thing as an *igneous fluid*?—Is there any thing that can with propriety be called *caloric*?"

He then says, "We must not forget to consider that most remarkable circumstance, that the source of the heat generated by friction, in these experiments, appeared evidently to be *inexhaustible*."

"It is hardly necessary to add, that any thing which any *insulated* body, or system of bodies, can continue to furnish *without limitation*, cannot possibly be a *material substance*: and it appears to me to be extremely difficult, if not quite impossible, to form any distinct idea of any thing, capable of being excited, and communicated in these experiments, except it be *motion*."

"I am very far from pretending to know how, or by what means, or mechanical contrivance, that particular kind of motion in bodies, which has been supposed to constitute heat, is excited, continued, and propagated, and I shall not presume to trouble the Royal Society with mere conjectures."

It must, however, be considered, that there is no friction which does not produce compression; *viz.* a contraction of the bulk of the bodies concerned, at least for a time; and therefore that the *caloric* is forced out of the bodies themselves; and, being communicated to the surrounding bodies, produces the usual signs of heat. It is a strong corroboration of this assertion, that substances, which are not compressible, are not heated by mechanical force; thus, a flint

will only be broken, but a piece of soft metal will be heated, by the strokes of a hammer. Thus, also, you may place any weight upon a quantity of water, without altering its temperature, because the compressibility of water is next to nothing; but if you place an additional weight upon a quantity of air; the bulk of the air will be contracted, and its temperature will be raised.

By about 15 or 20 smart and quick strokes of a hammer on the end of a soft iron rod of about a quarter of an inch in diameter, placed upon an anvil, an expert blacksmith will render that end of the rod visibly red-hot; and the softer the iron is, the quicker the effect will take place. But the production of vivid red sparks from a piece of steel, when struck against the edge of a flint, is a phenomenon not less curious. These particles are scraped off by the flint, and are of course compressed so as to become red-hot.

"One of the most remarkable circumstances, attending the production of heat by friction," says Dr. Young, "is the discovery of professor Piéctet, that it is often much more powerfully excited by soft substances than by harder ones. In making some experiments in a vacuum, in order to examine how far the presence of air might be concerned in the effects of friction, he accidentally interposed some cotton between the bulb of his thermometer and the cup, which was subjected to the friction of various substances as it revolved; and he found that the soft filaments of the cotton excited much more heat, than any other of the substances employed."

II. When a body heated above the actual temperature of the atmosphere, is placed amongst other bodies, the superfluous heat of the former is communicated to the latter; for there is no known body that can effectually intercept the transition of heat from one substance to another. But there is a remarkable phenomenon attending the communication of heat, which is neither very obvious, nor easily observed. This is, that in the distribution of heat amongst a variety of substances, some bodies absorb more of it than others, though they be all placed exactly in the same situation; hence different bodies are said to have different *capacities* for absorbing heat. (See HEAT, SPECIFIC HEAT, or SPECIFIC CALORIC.) So that if a certain quantity of heat is communicated to a mixture of equal weights of water and of mercury; the water will imbibe a much greater share of that heat than the mercury, and yet both will appear of the same temperature.

Now it has been found that by mixing certain bodies together, their capacities for absorbing heat is diminished; therefore they part with a portion of their heat, which is of course communicated to the surrounding bodies. Thus, when a pint of spirit of wine is mixed with a pint of water, the mixture grows sensibly hot, because their capacities for containing heat are diminished in consequence of their action upon each other. And it is to be remarked that whenever heat is emitted in the act of mixing fluids, as in the above-mentioned example of water and spirit, or of water and sulphuric acid, &c. a concentration of bulk takes place; thus the above mixture of a pint of water with a pint of spirit will be found to measure less than two pints.

In combustions, the heat which is first communicated by the contact of an ignited body, or otherwise, decomposes part of the combustible body, and of the surrounding oxygen air, which produces more heat, and this decomposes more of those bodies, and so the combustion proceeds and continues as long as there are combustibles and oxygen air ready for the process. See EXCITATION of heat.

EMISSION of Light. The perception of objects, which we receive through our sight, is obtained by the intermediation of

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of something; which we call *light*. Hence the blind must judge of the presence of particular objects, by means of the sound, or the smell, or the touch, &c. but not by the means of light. In short, light does not sensibly affect any other part of our bodies, besides the eyes. It follows then, that something must pass between any object we see and our eyes, but concerning this something we have no certain knowledge. A variety of conjectures and hypotheses have been offered; but of these hypotheses two only may deserve our attention. Descartes, Huyghens, and others, thought that a subtle fluid was dispersed throughout the universe; that the luminous bodies, such as the sun, the stars, a lighted candle, &c. put that fluid, not in a progressive, but in a certain vibratory motion; (somewhat like the motion which is communicated to the air by sonorous bodies;) and that this motion, being communicated to the nerves of our eyes, rendered the luminous objects perceptible to us. Newton and his followers suppose that light is a real emanation from luminous objects; *viz.* that a subtle fluid, consisting of certain peculiar particles of matter, proceeds from the luminous bodies; and by entering our eyes, excites in us the sensation of light, or the perception of luminous objects. A variety of facts and considerations seems to render this Newtonian hypothesis of light by far the most probable of the two. See the article **LIGHT**.

Admitting then Newton's hypothesis, several consequences, which naturally depend upon it, demand a particular illustration; *viz.* this emission of light must consist of particles; those particles must have a very minute, but determinate, size;—they must be at certain distances from each other; must move with a certain velocity, and must have a certain momentum. Several remarkable discoveries that have been made in astronomy, and in other branches of natural philosophy, enable us to determine the above-mentioned particulars, not with absolute precision, but within certain limits of probability. The facts upon which this probability rests, are as follows.

If a small hole be made in a screen, and the screen be placed before our eyes, as about the distance of five or six feet; and if a luminous body, as a red-hot coal, be repeatedly passed before that hole, on the other side of the screen, we must naturally perceive the hole luminous at intervals of time. But if the interval of time, during which the coal is not before the hole, be less than the tenth part of a second, then the hole will appear constantly luminous, exactly as if the red-hot coal were held steadily before it. This shews that the impression of light upon our eyes continues a certain time after the removal of the luminous objects. This is also the reason why, when a stick with a lighted extremity is quickly turned round in a circle before our eyes, we perceive an uninterrupted luminous circle.

The duration of the impression of light upon our eyes is longer or shorter, according as the object is more or less luminous; so that the impression is proportionally strong. See the article **VISION**.

Astronomers have observed, that the eclipses of the satellites of Jupiter appear to take place sooner than the time which is determined by the tables of their motions, when the planet is nearer to us; and later when that planet is farther from us. Hence it is naturally conjectured, that light moves progressively, and equally; *viz.* that it employs a certain time in going through a certain space; and this conjecture is corroborated by other astronomical observations. The calculations, which have been made upon these appearances, shew that light moves at the astonishing rate of, at least, 170,000 miles per second; so that in its motion from the sun to us, light employs about  $9\frac{1}{2}$  minutes.

If a small hole be made in a screen, and several persons are situated on one side of the screen; every one of them looking through that hole at a different object placed on the other side of the screen; it is evident that the various streams of light from those objects to the eyes of the observers, must pass through the same small hole in different directions, and without disturbing each other, at least in an observable degree. This shews, that the particles of light must be so very small, and so distant from each other, as not sensibly to obstruct each other's passage through a very narrow aperture.

In some experiments (rather imperfect) which were made by throwing the focus of a concave mirror upon the extremity of a very delicate beam, which was nicely suspended, a slight motion was thereby communicated to the beam; whence it was deduced, that the light thus collected had a sensible momentum. From the weight of the beam, and from the motion which it had received from the impulse of the light (upon the supposition that its motion was occasioned by it); also from the above-mentioned velocity of light; it was calculated, that the quantity of matter, which was contained in the light which was thrown upon the end of that beam, during one second of time, and which was collected from a reflecting surface of about four square feet; amounted to no more than one twelve hundred millionth part of a grain. (Priestley's *Hist. of Light, Vision, &c.* per. vi. sect. i. chap. 3.) These facts, joined to our daily experience, seem to authorize the following conclusions.

1. Since every physical point of a luminous object may be seen from every point of an immense spherical space which surrounds it, when no opaque body is interposed, it follows, that the streams of light, which proceed from all the points of visible objects, and move in all manner of directions, are past all conception. If this be alleged as an objection to Newton's theory, the least reflection will shew, that it offers an objection equally great, if not greater, to the other hypothesis that has been mentioned above; but the following reasoning will, in great measure, clear the difficulty with respect to Newton's hypothesis.

2. It has been mentioned above, that the impression of light remains a certain time upon our eyes, and (in the experiment with the red-hot charcoal) it has been shewn to remain about one-tenth part of a second; but suppose it to remain only during the 100th part of a second. Then it is evident, that if 150 particles of light be emitted in a second from a single point of a luminous object, as from a point on the surface of the sun; these particles will be more than sufficient to give our eyes an uninterrupted vision of that point; yet still these particles, on account of their immense velocity, may be more than 1000 miles distant from one another, and, of course, may leave room enough for millions of other particles to pass in all directions. Canton's *Calcul. Ph. Tr.* vol. 58.

3. The waste of the substance of a luminous body, arising from the emission of light, considering the minute nature of its particles, is very trifling, even with respect to the sun, which has been the great fountain of light during so many centuries. Dr. Priestley, alluding to the above-mentioned experiment, where an impulse was communicated to a beam by concentrated light, says, "Now the light in that experiment was collected from a surface of about four square feet, which reflecting only about half what falls upon it, the quantity of matter contained in the rays of the sun, incident upon a square foot and half of surface, in one second of time, ought to be no more than the twelve hundred millionth part of a grain. But the density of light at the surface

surface of the sun is greater than at the earth in the proportion of 45,000 to 1; there ought, therefore, to issue from one square foot of the sun's surface in one second of time, in order to supply the waste by light, one-forty thousandth part of a grain of matter; that is, a little more than two grains in a day, or about 4,752,000 grains, which is about 670 pounds avoirdupois, in 6000 years." *Hist. of Light, &c.* p. 390.

4. In consequence of the motion of light, it is evident, that if a luminous body were suddenly placed in the heavens, at the same distance that the sun is from us, we could not possibly see it before the lapse of  $8\frac{1}{2}$  minutes. Also, when we behold a celestial object, we do not see it exactly in the place where it actually stands; but we see it in the place where it stood some time before.

5. Light moves in straight lines, as long as it goes through the same uniform medium, or through a vacuum.

6. When we direct our eyes towards certain polished surfaces, we frequently see in them the appearances of objects, which are situated in places quite different from those in which we see them. In this case the rays of light coming from those objects fall upon the polished surfaces, and from them they are *reflected* (that is, *sent back*) to our eyes. Those objects then are said to be seen by reflected light, and the surfaces in which their appearances are seen are called the *reflecting surfaces*. Indeed, every body which does not itself emit any light, (as is the case with all those which cannot be discerned in a dark room,) are seen by reflected light; for the light which is emitted from the sun, from a candle, from a fire, &c. falls upon those bodies, and is from them reflected to our eyes; but that light is reflected irregularly on account of the inequalities on the surfaces of most bodies; so that though all bodies which do not shine of themselves, are seen by reflected light; yet they are called reflectors, or are said to have reflecting surfaces, only when those surfaces are smooth and polished, in which case they reflect the light regularly, so as to represent the images of other objects, that are placed before them. See REFLECTION OF LIGHT.

7. In its passage from one body into another, or from a vacuum into any substance, and *vice versa*, light is often bent in its direction; and that bending is called the *refraction of light*. See REFRACTION OF LIGHT.

8. Light is likewise bent in its direction, when it passes close by the surfaces of bodies; and this bending is called the *inflection of light*, which see.

The sources of light are various, but they may be comprised under the following enumeration.

1. The celestial bodies, which shine either by their own light, as the sun and the stars; or by reflected light, like the moon and the satellites.

2. The *aurora borealis*, and other meteors, whose nature is not as yet distinctly known.

3. Bodies that are in a state of *combustion*, and emit heat as well as light.

4. The *electrical light*; and,

5. The *phosphorescent bodies*, of which there are several species, *viz.* 1. The *phosphorus* properly so called, which is considered as an elementary substance. 2. The living animals which have the property of shining in the dark, such as glow-worms, lantern-flies, &c. 3. Those bodies which absorb light when exposed to it, and then emit it in the dark; such are several precious stones, calcareous bodies, Canton's phosphorus, the Bolonian stone after due preparation, &c. 4. The bodies which emit light when they are heated to a certain degree; fluoric stones, several marbles, calcareous earth, &c. have this property. 5. The

substances which emit a light either quite white, or tinged with different shades of red or blue, by attrition; *viz.* by being rubbed or struck against each other. Most stones of the silicious kind possess this property. 6. And lastly; those bodies which emit light without any sensible heat, whilst they actually are under a state of decomposition; and of this sort are most animal matters, and some vegetable substances, especially rotten wood.

The doubtful nature of the *ignis fatuus*, or *jack-a-lantern*, may perhaps also be reckoned amongst the phosphori. See AURORA BOREALIS, ELECTRIC LIGHT, METEORS, PHOSPHORUS, PHOSPHORESCENT BODIES, and IGNIS FATUUS.

EMITES, in *Natural History*, a name used by some authors for the chermites, a beautiful species of white marble, of which the tomb of Darius, and many other of the great works of antiquity, were made. It was valued for its fine polish.

EMLY, in *Geography*, a village of the county of Tipperary, province of Munster, Ireland, the see of a bishop; which was united to Cashel in 1568. It is 15 miles W. from Cashel.

EMLYN, THOMAS, in *Biography*, an eminent nonconformist divine, was born at Stamford, in the county of Lincoln, in the year 1663. His parents, though accustomed to attend the religious service of the established church, thought so favourably of the principles of the Protestant dissenters, that they determined to educate their son for the ministry among persons of this description. Accordingly, he was placed for academical instruction in the year 1678, under the care of Mr. Shuttleworth, who resided at Sulby, near Welford, in Northamptonshire. In the following year he was admitted at Emanuel college, in the university of Cambridge; but afterwards returned to Mr. Shuttleworth, under whose tuition he remained for four years. With a view to the enjoyment of superior advantages, he removed, in 1682, to the academy of Mr. Doolittle in the vicinity of London, and in this situation he diligently availed himself of the collateral means and opportunities of improvement, afforded him by an access to books, and intercourse with literary persons; and made such improvement in the knowledge, connected with his profession, that he was encouraged to commence the exercise of his profession in December, 1682. His mind, at this early period, disdained the shackles of established systems of theology; and he determined to inquire freely, and to exercise, independently of the controul of authority, the right of private judgment. It was favourable to his future improvement, that he was not under a necessity of immediately connecting himself with a congregation, and of devoting his whole time to necessary preparation for the public services of his profession. In the year 1683, he became chaplain to the countess of Donegal, and accompanied her to Belfast in Ireland, where he had a liberal appointment, and was treated with respect and kindness. The countess married sir William Franklin, a gentleman of considerable property in the west of England, who offered our young divine a valuable living in that country; but not approving the terms of ministerial conformity, he declined the acceptance of it. His sentiments, however, were so liberal, that he regularly attended the public services of the established church, and was himself attended in the evening, when he officiated in the countess's hall, by the minister of the parish, with whom he cultivated an intimate acquaintance. He likewise occasionally officiated in the parish church, having obtained, without subscription, a licence to preach from the bishop of the diocese. At this time he visited Dublin, and

and his services were so acceptable to the congregation, of which Mr. Daniel Williams and Mr. Joseph Boyce were pastors, that he was afterwards induced to settle among them. In the mean while a variety of circumstances occurred in the agitated state of the north of Ireland, and the domestic disunion of the family of his patroness, which rendered it expedient for Mr. Emlyn to remove to England. Accordingly in the year 1688, he came to London, where he renewed his acquaintance with Mr. (afterwards Dr.) Daniel Williams, who had relinquished his pastoral connection with the congregation at Dublin. As he passed to and fro from Ireland to London, he was accustomed to preach in several parish churches; and at Liverpool in particular, where he had accidentally officiated, his preaching was so much approved, that upon the decease of the parish minister, whose place he had supplied, several of the inhabitants expressed their wishes, that they might be allowed to procure for him the living. But this offer, however respectful on their part, his principles would not permit him to accept. In 1689, Mr. Emlyn, being altogether unemployed, was invited by sir Robert Rich, one of the lords of the admiralty, to his residence near Beccles in Suffolk; and he was induced to officiate to a dissenting congregation at Lowestoff, where he continued about a year and a half; though he declined complying with their invitation to undertake the pastoral office. The liberality of his sentiments and conduct, during his abode in this place, served to promote a perfect harmony between the members of the established church and the dissenters. Here he became acquainted with Mr. William Manning, a respectable non-conformist minister in the neighbourhood; and their mutual intercourse led them both to adopt sentiments, with regard to the doctrine of the Trinity, in vindication of which Dr. Sherlock's treatise had just appeared, very different from those which they had hitherto entertained. Mr. Manning became a Socinian; but Mr. Emlyn adopted what has been generally called the Arian opinion, believing the pre-existence of our Saviour, as the Logos, and that by him God had created the material world. To this opinion he adhered through life. Upon the abdication of king James II., the turbulence of Ireland in some degree subsided; and Mr. Boyce urged Mr. Emlyn, to join him in the pastoral care of the dissenting congregation in Wood street, Dublin. After much previous deliberation, he accepted the proposal, and, in 1691, removed to Dublin. Here he soon acquired distinguished reputation as a preacher. His discourses were rational, persuasive, and pathetic; his voice was clear and strong, and his delivery dignified and graceful; the devotional services were conducted with great propriety; controversial subjects were avoided; and all the private duties of a Christian pastor were discharged in an exemplary manner. In 1694, Mr. Emlyn married Mrs. Esther Bury, a widow lady, with a handsome jointure; and he was thus enabled to maintain a respectable appearance. After considerable hesitation and suspense, he determined, when a proper occasion offered, to avow his opinion concerning the doctrine of the Trinity. But before the formal execution of his purpose, he met with various domestic troubles. In 1701, he lost both his son and his wife; the latter affliction deeply wounded his feelings, and led him to that admirable train of meditation, which is pursued in the funeral sermon preached on the occasion, and which was printed under the title of "Funeral Consolations." Soon after he was bereaved of his wife, and whilst his mind was in an unfit state to encounter new conflicts, his opinion concerning the Trinity became the subject of investigation. Dr. Cummins, a physician of Dublin, and a member of his congregation, communicated his suspicions to

Mr. Boyce; and they determined to apply to Mr. Emlyn for a declaration of his real sentiments. Having explicitly avowed his opinion, that the God and father of Jesus Christ is alone the Supreme Being, and that the son derives his excellence and authority from him, he offered to withdraw quietly from the congregation, and thus to prevent the disturbance that was likely to ensue. But this pacific measure was unsatisfactory. Mr. Boyce, in a manner that reflects disgrace on his memory, brought the matter before the Dublin ministers, who, after a candid declaration of his sentiments on the part of Mr. Emlyn, immediately forbade him to preach any more. His congregation, during this precipitate course of proceedings, was never consulted on the occasion. Mr. Emlyn avowed his sentiments to the deacons and principal managers of the church; and after respectfully acknowledging their kindness to him, requested his dismissal. The conduct of his accusers was the cause of much surprize and concern to the congregation, and Dr. Cummins himself regretted the part which he had acted. However, it was at length determined that Mr. Emlyn should retire for an interval to England; and such was the violence of the Dublin ministers, that, notwithstanding the great inconvenience and expence, to which he was constrained to submit, two of their number were deputed to "charge him not to preach any where when he went thither." These persecutors followed him with their letters of accusation to London, and endeavoured to deprive him of the benefits of that candour and charity which he experienced on his arrival. Whilst he remained in London, he published a short account of his case; and after an absence of 10 weeks, he resolved to return to his family in Dublin. In order to obviate the prejudices that were entertained against his person and doctrine, he wrote his "Humble Inquiry into the Scripture account of Jesus Christ, or a short Argument concerning his Deity and Glory, according to the Gospel." He then determined to return to England; but his purpose was prevented by the persecuting spirit of his enemies, who obtained a special warrant from the lord chief justice to seize our author and his books. At first the chief justice refused bail; but afterwards allowed it, when two sufficient persons became bound in a recognizance of 800*l.* for Mr. Emlyn's personal appearance. In the next term the grand jury found a bill against him, in which he was indicted of blasphemy. The trial came on in June 1703; and it was conducted in a manner no less disgraceful and tyrannical than the proceedings of a board of popish inquisitors. The jury were intimidated to deliver their verdict, and to bring in the defendant guilty, for which some of them afterwards expressed their concern. After the verdict was pronounced, the attorney-general moved, that the author might have the honour of the pillory; but sentence was deferred till the last day of the term. In the mean time Mr. Emlyn was committed to the common gaol. Mr. Boyce now began to relent, and used all his interest to prevent the passing of the cruel sentence threatened by the attorney-general. Mr. Emlyn also, in deference to the advice of his friends, wrote a letter to the lord chief justice, which was indited with a spirit, and in a style which ought to have influenced his mind. When he appeared to receive judgment, one of the queen's council moved that he should retract; but Mr. Emlyn would not consent. The lord chief justice, therefore, sentenced him to suffer a year's imprisonment; to pay a fine of 1000*l.* to the queen, and to lie in prison till it should be paid; and to find security for his good behaviour during life. He was given to understand, that though the pillory was due to his crime, this punishment was not inflicted, as he was a man of letters. After sentence was pronounced,

he was led round the four courts with a paper on his breast, to be exposed. For more than a quarter of a year, he was kept a close prisoner in the under-sheriff's house; and after the expiration of this term he was hurried away to the common gaol, where he lay among the prisoners in a close room, filled with six beds, for about five or six weeks; and then he was removed upon his petition, by *habeas corpus*, to the Marshalsea, on account of his health. In this prison he wrote, in 1704, a treatise, entitled "General Remarks on Mr. Boyce's Vindication of the true Deity of our Blessed Saviour." In this state of imprisonment, he remained until the month of July 1705, visited by few of his former friends, and altogether neglected by his savage brethren, the Dublin ministers. Mr. Boyce, indeed, should be excepted; and to his zealous and repeated sollicitations, to the generous interference of Thomas Medlicote, esq., the humane interposition of the duke of Ormond, and the favourable report of the lord chancellor, that the exorbitant fine passed upon him was illegal, his release from confinement was owing. By their exertions the fine was reduced to 70*l.*, which was actually paid into her majesty's exchequer; but the archbishop of Armagh, the queen's almoner, who had a claim of 1*s.* in the pound upon the whole fine, insisted on the whole sum, nor would he extend his charity to a conscientious sufferer till he received 20*l.* by way of composition for the 50*l.* to which the sentence entitled him. During Mr. Emlyn's confinement in the Marshalsea, he constantly preached on Sundays to some of the imprisoned debtors, and several of the lower class of his former hearers. Soon after his release Mr. Emlyn removed to London, where he preached once every Sunday to a small congregation of persons of sentiments similar to his own, but without receiving any salary. Attempts were made to restrain him by Charles Leslie, the famous non-juror, and also by the lower house of convocation, but by the moderation of archbishop Tenison, and the interference of government, they were unsuccessful. Mr. Emlyn's congregation gradually declined by the death of his hearers, and was at length dissolved; upon which he retired to obscurity, and employed himself in vindicating, by various publications, the principles he had adopted; and the cause to which he was devoted. One of his most elaborate productions was entitled, "A Vindication of the Worship of the Lord Jesus Christ, on Unitarian principles," and published in the year 1706. One of his most curious works was published in 1710, and was entitled "The Previous Question to the several Questions about valid and invalid Baptism, lay Baptism, &c. considered, viz. whether there be any necessity, (upon the principles of Mr. Wall's History of Infant Baptism) for the continual use of Baptism among the posterity of baptized Christians." In 1715, he published his "Full Enquiry into the original Authority of the Text, 1 John, v. 7, &c. containing an account of Dr. Mill's evidence from antiquity, for and against its being genuine, &c." In this controversy there appeared, pro & con, several tracts, the titles of which we cannot recite in this place, nor can we mention the various publications of Mr. Emlyn on the subject of the Trinity. In 1719, he published "A true Narrative of the proceedings of the Dissenting Ministers of Dublin, against Mr. Thomas Emlyn, and of his Prosecution, (at some of the Dissenters' Instigation,) in the secular court, &c." Mr. Emlyn, though himself unpopular, had the satisfaction to observe, that the opinion for which he suffered excited attention, and gained advocates, both in England and Ireland. Although none of the dissenting ministers in London could dare to ask him to preach for them, except Mr. Burroughs, and Dr. James Foster, he was

honoured with the esteem and friendship of many persons, distinguished by their station and learning; and particularly by Dr. Samuel Clarke, and Mr. Whiston. Upon the death of Mr. James Pierce of Exeter, about the year 1726, it was proposed to invite Mr. Emlyn to be his successor; but he wished them to decline all thoughts of him, as his advanced age, and increasing infirmities would not permit him to accept the office. The gout had much impaired Mr. Emlyn's constitution, and he at length fell a martyr to it, on the 30th of July, 1743, in the 79th year of his age. A complete collection of his works was made in 1746, and is comprised in two vols. 8vo.; to which are added memoirs of his life, written by his son Sollom Emlyn. His sermons are separately published in one volume.

EMMA, in *Biography*, daughter of Richard II. duke of Normandy, wife of Ethelred king of England, and mother of Edward the Confessor, had a considerable share of power during her son's reign. The duke of Kent, who was jealous of her great ascendancy, and desirous of getting rid of her as a rival, caused her to be accused of several high crimes, to which the king her son too readily listened, and not only deprived her of all those immense treasures which she had amassed, but confined her for life in the monastery of Winchester. Some historians go much farther, and contend that she was accused of murder, and of incontinence with the bishop of Winchester, but Mr. Hume considers such reports, and the story of her being obliged to justify herself by walking over the nine red-hot plough-shares, as the inventions of Monks, and propagated for the sake of exciting the silly wonder of posterity. Bayle, however, gives full credit to the facts, and adds that the king, now sensible of the complete innocence of his mother, and penitent for the sufferings he had inflicted on her, submitted his back to the scourge. Hume. Bayle.

EMMAUS, in *Ancient Geography*, a village of Palestine, 60 furlongs N. of Jerusalem; mentioned, Luke xxiv. 13, as the place whither two of our Lord's disciples retired on the day of his resurrection, and where he joined them in the form of a traveller, and demonstrated to them, that the Messiah was to suffer death and to rise again; and where he discovered himself to them at supper, while he was breaking bread. At this place were hot baths; and a church was erected on the spot where Cleopas, one of the fore-mentioned disciples, stood. Josephus informs us, that Vespasian left 800 soldiers in Judea, to whom he gave this village.

EMMAUS, a city of Judea, 22 miles from Lydda, afterwards called *Nicopolis*, and different from the village of Emmaus, though often confounded with it. Mr. Reland proves these to be different places from the testimonies of Josephus, St. Jerom, the Maccabees, and the Talmudists. In this Emmaus, or Nicopolis, there were hot baths, in which, as the tradition of the inhabitants reports, our Lord washed his feet, and communicated a healing virtue to them. Julian, the apostate, from enmity to Christ, gave orders for stopping up this fountain.—Also, a town near Tiberias, in which were hot waters. Joseph. de Bell. l. iv. c. 1.

EMME, in *Geography*. See EMMENTAL.

EMMELIA, *Εμμελία*, in *Antiquity*, a dance peculiar to tragedy, which had all the gravity and dignity that were suitable to the action then representing, and was designed to inspire the audience with sentiments of compassion and benevolence for the unfortunate and oppressed, with indignation against the guilty, and with the love of virtue, and abhorrence of vice. The happy mixture of noble and elegant con-cords, together with an exquisite modulation in the action of the personages, denoted by emmelia, is strikingly exemplified in that piece of *Æschylus*, in which king Priam offers

a ransom for the body of his son. The chorus of Trojans, prostrate with him at the feet of the conqueror of Hector, and like him uttering, amid their dignified emotions, expressions of grief, fear, and hope, communicate to the soul of Achilles, and those of the spectators, the sentiments with which they are penetrated.

The movements of such a dance as this must have been very solemn and majestic, and have bore a great affinity to the action of an orator; it was the only one, excepting the military dances, that had the approbation of Plato. Mem. Acad. Inscript. vol. ii. p. 160. See DANCE.

EMMELIA, in *Music*, tuneful sounds among the Greeks, such as were fit for melody.

EMMELOORT, in *Geography*, a town in the north part of the island of Schockland, in the Zuyder sea; 10 miles E. of Vollenhove.

EMMENAGOGUES, MENAGOGA, in *Medicine*, are such substances as are understood to possess the power of exciting the menstrual discharge in the female sex.

Both the ancient and modern writers on the *Materia Medica*, but especially the former, mention a great number of medicines, to which they attribute this power, and speak of it with considerable confidence. But the articles, to which an emmenagogue quality has been thus ascribed, have not succeeded in the hands of the physicians of cautious observation in our own times; so that it is now generally admitted, that we are not in possession of a medicine, which has any specific power in stimulating the vessels of the uterus. Dr. Gregory asks, in his *Lectures*, "What effect a medicine, possessed of such a power, could have upon men?" which he seems to consider as an unanswerable refutation of the notion of emmenagogues. But may we not equally disprove the existence of a diuretic medicine, by inquiring what effect such a medicine would produce in animals which have no kidney? Experience, however, amply corroborates the opinion; and the operation of those substances, which have occasioned the catamenia to flow, is explicable on other principles than that of a specific stimulus to the uterine vessels. But it is also to be remarked, that there is great room for deception with respect to the operation of medicines, in restoring or exciting the menstrual discharge; and that the fallacious conclusion of "post hoc, ergo propter hoc," has given a character of efficacy to many medicines, (in all departments of practice, but in this most eminently,) which in truth possess no such power. The catamenia frequently appear spontaneously, after long retention or suppression; and whatever medicine happens to be under administration at that time gains the credit of the cure.

There is an error almost universally prevalent among the women themselves, and sanctioned by gossiping meddlers, that the suppression of the menses is the *cause* of almost every disorder which the female constitution can suffer; and consequently, that its restoration, in these cases, is the most important point to be attended to in their treatment. Now the converse of this position is much nearer the truth. The suppression of the catamenia is most commonly the *effect* of a previously disordered state of the constitution, and will be removed, as a matter of course, when the health in general is restored. Hence, such a suppression is one of the symptoms of almost all chronic diseases, and debilitated conditions of the body: it is sometimes the consequence of the opposite state, of a plethoric or inflammatory diathesis. The remedies, therefore, which possess an emmenagogue power, operate indirectly upon the uterine system, through their effects upon the system at large; and are consequently of opposite qualities, as they apply to two opposite condi-

tions of the constitution: or, they operate locally upon the adjoining parts, and affect the uterus from its contiguity.

The retention of the catamenia in young women, about the age of puberty, is generally connected with extreme debility of the system, often with that morbid change of complexion which designates the green-sickness, or *Chlorosis*, which see. It is in such cases, that preparations of iron, bark, and other tonic medicines, may be deemed emmenagogues, by restoring the general tone of the habit: the chalybeates have been particularly extolled for their emmenagogue powers. But in full florid habits, when the catamenia are suddenly suppressed, laxatives, diaphoretics, and even blood-letting, most effectually contribute to restore the discharge. Many other reputed emmenagogues operate as local stimuli to the contiguous parts: hence aloes, and other warm purgatives, which irritate the lower portion of the intestines, have been celebrated for their emmenagogue powers. Electricity, applied through the pelvis to the hips and back, has sometimes been an efficacious emmenagogue. Savine, castor, the fetid gums, the warm-bath, and pediluvium, may be deemed stimulants to the uterus, as a part of the general system: the efficacy of the warm-bath, or slipper-bath, when employed about the expected period of menstruation, is often very great. Dr. Mead highly extolled the tincture of black hellebore, which, he says, seldom failed in his practice; and he attributed to it such a stimulative power over the blood-vessels, that when it did not produce the menses, he affirms, the blood was driven through other outlets, as from the nose, bowels, &c. But Dr. Home, and many other physicians, have used it largely in vain. Dr. Home attributes some powers to the savine, and much to madder (*rubia tinctorum*); which, however, has appeared to others to be altogether inert. Cullen *Mater. Medica*, vol. ii. Home *Clinical Exper.* p. 377. See AMENORRHOEA.

EMMENDINGEN, in *Geography*, a small town of Germany, in the grand duchy of Baden Durlach, situated on the river Eltz, in the district of Hochberg, the neighbourhood of which produces excellent wine; but it is chiefly remarkable for a fruitless conference, which was held here in the year 1590, between the Roman Catholic and Lutheran divines of Germany. Emmendingen is on the high road from Switzerland to Franckfort, on the Mayn.

EMMENTHAL, one of the finest and richest valleys of Switzerland, in the canton of Aarau, deriving its name from the river Emme, by which it is irrigated. The principal towns are Signau, Trachelwald, Soumifwald, and Braudis. Its cheese is known all-over Europe under the name of "fromage de Gruyeres."

EMMERAN, SAINT, formerly a rich imperial abbey of Germany, in the town of Ratibon. Its possessions form now a part of the territory of the prince primate of the Confederation of the Rhine.

EMMERICH, or EMMERICK, a small town of Germany, in the grand duchy of Berg, situated on the Rhine, in the former duchy of Cleves; 9 miles E. of the town of Cleves, and 24 miles S.E. of Nimeguen. N. lat. 51° 39'. It has a considerable trade with Holland, and was anciently one of the Hanseatic towns. Its origin dates from the year 1247, when it was first surrounded with walls.

EMMELIURE, in the *Manege*, a kind of composition of honey, and other ingredients, used for sprains and shoulder-splaits of horses. See CHARGE.

The word is French, derived from *miel*, honey, which is a part of the composition.

EMMIUS, URBO, in *Biography*, a learned philologist and historian, was born in 1547, at Gretha, a village in

East Friesland, of which his father was the pastor. In his studies he was diligent and remarkably successful. His natural timidity and bashfulness prevented him from undertaking the office of minister; and in 1579, he engaged as master of the school of Norden, in East Friesland, which he conducted with great reputation, till he was harassed by bigots for refusing to subscribe the confession of Augsburg; and at length not only deprived of his salary, but prohibited from teaching. From Norden he went to Leer, where he undertook the same office, to the great injury of his late school. When Groningen associated itself with the United Provinces, and planned the re-establishment of its college, Emmius was chosen its director, with the full power of forming such statutes for its government as he should think proper. In this office he continued 20 years, when the college was erected into an university; and Emmius was appointed professor of history and Greek, in which he gave lectures to a very advanced period of life. He died at Groningen, in 1625, in the 79th year of his age, highly respected by all with whom he was connected; and his memory was so much honoured, that the magistrates, to whom he had been an able counsellor on all important occasions, placed his portrait in the town-house. He published many valuable works on history, chronology, and antiquities: among these are, "Decades Rerum Frisicarum;" "Vetus Grecia illustrata," in three volumes, which is highly esteemed as a valuable summary of the geography, history, polity, &c. of ancient Greece. It is recorded of him in his life, that he was so thoroughly versed in the histories of all kingdoms and countries, that, at the request of his friends, he could at any time, and without previous consideration, speak upon the history of all kingdoms and countries, beginning with any period that might be fixed on, and give a complete detail of all the places, times, and circumstances of persons, as if he had come prepared expressly to explain those histories. Eulogies were pronounced on his memory by Thuanus, Scaliger, Douza, Heinsius, David Chytræus, and others. By Scaliger his history of Friesland is called "divine." Bayle.

EMO, or EMO Inn, in *Geography*, in the Queen's county, province of Leinster, Ireland, has been made a post-town, and is much frequented by travellers, as a convenient stage. Adjoining it is Emo-park, the seat of the earl of Portarlington. Emo is 35 miles S.W. from Dublin, and 5 E. from Maryborough.

EMODI MONTES, or *Emodi Mons*, in *Ancient Geography*, part of a chain of mountains in Asia. Pliny says, that the Emodus, the Imaus, the Paropamisus, and the Caucasus, were connected together; and that the Serres inhabited the country beyond these mountains. Dionysius Periegetes places the springs of the Oxus in the Emodian mountains, and extends this chain as far as the Eastern ocean. The mountains Emodus and Imaus, according to major Rennell, are the mountains which extend from the Ganges, above Sirinagur, to Cashmere: separating the dependencies of Hindoostan from those of Great Thibet. This ingenious geographer suspects Emodus and Imaus to be different readings of the same name; and Emaus or Himaus are, without doubt, derived from the Sanscrit word *Himmalech*, signifying snowy. That vast ridge bears the same name at present; and Pliny (l. vi.) well knew the circumstance. The mountains of Rimola, so called in the Lama's map, to which the territories of Napaul extended, were anciently denominated Emodus; and they are a continuation of the chain between Tassudon and Paridrong.

EMODIA, *Αιμαδία*, of *αίμα*, blood, and *οδός*, tooth, in

*Medicine*, a word used by some authors to express a stupor of the teeth.

EMOLLIENTS, are medicines which, when externally applied, have the power of relaxing or softening the fibres, when too rigid. They have all been supposed to act mechanically, but this may be doubted. The commonest form of emollient is a cataplasm or poultice of bread and milk, or other mucilaginous vegetable matter, applied to the skin as warm as can be borne without pain. The relaxation and consequent ease which warm cataplasms produce is very great; but as none of the materials can be readily absorbed through the cuticle, when unbroken, the emollient effect has with great probability been attributed chiefly, if not entirely, to the relaxing effect of warmth and moisture upon the extreme vessels of the living surface, unconnected with any supposed interposition of moisture between the moving fibres.

The other class of emollients comprehends unctuous bodies of all kinds, when assisted by friction; and as there is no doubt of a considerable absorption taking place in this method, it is not improbable that the fibres may be actually softened, and rendered more flexible by mechanical operation. No comparative experiments have yet been fairly made to decide whether one unctuous body is more penetrating, that is to say, more readily absorbed by the skin, than another; so that, as mere emollients, they all have equal claim to use.

EMOLUMENT, is properly applied to the profits arising daily from an office or employ.

The word is formed of the Latin *emolumentum*; which, according to some, primarily signifies the profits redounding to the miller from his mill; of *molo*, *molere*, to grind.

The patent, or other instrument, whereby a person is preferred to an office, gives him a right to enjoy all the dues, honours, profits, and emoluments, belonging thereto.

In our law-books, emolument is used in a somewhat greater latitude, for profit, or advantage, in the general.

EMOTION, in *Elocution*, a mode of utterance applied to appropriate passages and on proper occasions, expressive of disturbance and agitation in the mind of the speaker, reader, or reciter, and calculated to produce the like disturbance and agitation in the minds of the auditors. Under proper regulation of the judgment, this is one of the highest graces of elocutionary expression; nay, so eminently is it calculated to produce the effects at which the highest species of elocution principally aim, that it may sometimes be said most completely to attain its end, when the judgment of the speaker becomes for a while suspended, or is at least surrendered to its influence and domination. By some, however, it is disputed whether the elocutionist (especially the actor) ought really, (for the most perfect production of the effect desired,) to be under the positive influence of the emotion exhibited, or ought only to imitate, by the strong operation of judgment and recollection, so much of the actual emotion of real life, as appears calculated to excite the general or particular sympathy desired; and the writer of this article remembers an instance in which a public lecturer was much censured by a critical auditor, for having suffered himself to be overpowered by his own emotions, in describing the tragical fate of Virginia, under the tyranny of the Roman decemviri, that the last syllable of the sentence "he saved his honour, but he lost his child," expired in an almost inarticulate sob, and the orator, choked with tears, was unable to proceed any farther. The effect produced was, however, the best answer to this hypercriticism. The orator had already proceeded far enough; for although one person remained cold enough to criticise, a shriek of horror had

run through the audience, one half of whom had burst into tears of sympathy, and some of whom had actually swooned away; overpowered by contagious agitation. So superior is nature and reality, to the boasted mechanism of sophistification and art. Art, however, and the severest exercise of judgment, are necessary both to the actor and the orator, (especially to the latter,) in the direction and regulation of these emotions; that it may be known when, and how far they are to be indulged; the cases being very rare in which it can be safe and proper to throw the reins on the neck of feeling, and leave it to make its way to the goal, by its own independent energies. Emotion is partly expressed by change of time or momentum, in the action of the organs of enunciation, and by different degrees of irregularity in the succession and proportions of the cadences; and partly by the modulations of the voice; the intonations of which become modified by the different character of the passion to be expressed; while, in some instances, a tremulous expression, and in others frequent interruptions and abrupt transitions in the tune, considerably heighten the effect. Two things are principally to be avoided in the pursuit or cultivation of this excellence;—the unrestricted indulgence of such feelings as might hurry into coarseness, indecorous vehemence, or bombast; and that frigid affectation which aims at impression by unnatural or unappropriate tones; extremes, which though they may extort *applause* from “the unskilful,” always disgust “the judicious,” and disappoint completely the legitimate end which genuine emotion must have in view,—the excitement of a correspondent sympathy.

Physiognomical expression, or the play and sympathy of the features, and the language of gesticulation, must not be overlooked: for, as Mr. Sheridan has observed, it is a palpable “delusion,” to suppose, “that by the help of words, alone, we can communicate all that passes in the mind of man. The passions and the fancy have a language of their own, utterly independent of words, by which only their exertions can be manifested and communicated.” Lect. on Eloc.

In the recommendation of these accompaniments of elocution to any but the professed actor, the professor, however, must be aware that he has many and obstinate prejudices to encounter. The dullness and indolence of modern elocutionists having conspired, with other causes, to reduce almost all public speaking, but that of the stage, to one sympathetic monotony of tone, and look, and attitude, the superstition of criticism (mistaking sanction for propriety, and established usage for the law of nature) has raised a sort of hue and cry, against all expression of attitude and feature; as if these were mere theatrical affectations and meretricious artifices.

But this subject will be further pursued under the proper heads GESTICULATION and ORATORY; for the present it is only necessary to observe, that as essential to the perfection of that particular branch of the art, accompaniments of gesticulative and physiognomical emotion are universally admitted to be legitimate portions of the art of theatrical recitation, to the judicious application of which the elocution of the stage is indebted for a considerable part of its effect.

EMOTION, in the *Theory of the Mind*, is applied by Dr. Cogan (*Treatise on the Passions*) to the external marks, or visible changes produced by the impetus of passion upon the corporeal system. Thus he distinguishes it from passion, which denotes the violent impression made upon our minds by the perception of something very striking and apparently interesting, and from affections, which are applicable to the less violent, more deliberate, and more permanent impressions,

by causes which appear sufficiently interesting. The strong impression, says this writer, of vivid sensation, immediately produces a re-action, correspondent to its nature; either to appropriate and enjoy, or to avoid and repel the exciting cause. This re-action he distinguishes by the term *emotion*. The sensible effect produced at the first instant by the cause of the passion greatly agitates the frame; its influence is immediately communicated to the whole nervous system, and the commotions excited in that, indicate themselves both by attitudes and motions of the body, and particular expressions of the countenance. It is alone by these visible effects, that the subject is discovered to be under the influence of any passion; and it is merely by the particular changes produced, or kind of emotion, that we are enabled to judge of the nature of the passion. Thus, although the passion exists prior to the emotions, yet as these are its external signs, they must indicate its continued influence as long as they continue to agitate the system.

Sheridan, in his “*Art of Reading*,” discriminates between ideas and emotions. The former, he says, denote all thoughts which rise and pass in succession in the mind. Emotions signify all exertions of the mind in arranging, combining, and separating its ideas, as well as all the effects produced on the mind itself by those ideas, from the more violent agitation of the passions to the calmer feelings produced by the emotion of the intellect and the fancy. Thought is the object of the one, internal feeling of the other. That which serves to express the former Sheridan calls the language of ideas; and the latter the language of emotions. Words are the signs of the one, tones of the other. Without the use of these two sorts of language, it is impossible to communicate through the ear all that passes in the mind of man.

EMOY, or HIA-MEN, in *Geography*, an island near the S. E. coast of China, within the jurisdiction of the province of Fo-ken, about 15 miles in circumference. The port of Emoy is properly an anchoring-place for ships, inclosed on one side by the island from which it takes its name, and on the other by the main land; but it is so extensive, as to be capable of containing several thousand vessels; and its water is so deep, that the largest ships may lie close to the shore without danger. About a century ago it was much frequented by European vessels; but few visit it at present, as all the trade is carried on at Canton. The emperor keeps here a garrison of six or seven thousand men, commanded by a Chinese general. At the mouth of the road is a large rock, visible several feet above the surface of the water; and three leagues from it is a small island, with a natural arch in the middle which admits light from the opposite side; and hence it obtained the name of the “Perforated island.” The island of Emoy is particularly celebrated on account of the magnificence of its principal pagoda consecrated to the deity “Fo.” This temple is situated on a plain, terminated by the sea on one side, and on the other by a lofty mountain. The front of the edifice is 185 feet in length, and its gate is adorned with figures in relief, the usual ornaments of the Chinese architecture. At the entrance is a large portico, with an altar in the middle, on which is placed a gigantic statue of gilt brass, representing the god “Fo,” sitting cross-legged. Four other statues, 18 feet high, though representing persons sitting, occupy the four corners of the portico. Each of them is formed from a single block of stone, and bears in its hands appropriate symbols; *e. g.* one bears a serpent in its arms, twined round its body in several folds; another has a bent bow and quiver; the two others present, one a kind of battle-axe, and the other a guitar, or some similar instrument. Beyond this portico is an outer

court, having at its four sides four pavilions, terminating in domes, and communicating with one another by a gallery. In one is a bell ten feet in diameter: in another a drum of enormous size, used by the bonzes for proclaiming the days of new and full moons. The two other pavilions contain the ornaments of the temple, and often serve to lodge travellers, whom the bonzes are obliged to receive. In the middle of the court is a large tower, terminating in a dome, with a beautiful stone stair-case winding round it. The dome contains a neat temple, the ceiling of which is ornamented with mosaic work, and the walls covered with figures in relief, representing animals and monsters. The pillars that support the roof are framed of wood, varnished, and on festivals are ornamented with differently coloured flags. The pavement of the temple is formed of small shells, presenting in different compartments birds, butterflies, flowers, &c. The bonzes continually burn incense upon the altar, and keep the lamps suspended from the ceiling always lighted. At the extremity of the altar is a brazen urn, which, when struck, emits a mournful sound, and on the opposite side is a hollow machine of wood, used for the same purpose, which is to accompany with its sound their voices, when they sing in praise of the tutelary idol of the pagoda. The god "Poussa" is placed on the middle of this altar, on a flower of gilt brass, which serves as a base, and holds a young child in his arms; several idols, which are without doubt subaltern deities, are ranged around him, and by their attitudes shew their respect and veneration. Behind the altar is a kind of library, containing books which treat of the worship of idols. Across the court is a kind of gallery, containing 24 statues of gilt brass, representing philosphers, who were the ancient disciples of Confucius. At the end of the gallery is a hall, which is the refectory of the bonzes; and beyond a spacious apartment is the temple of "Fo," to which there is an ascent by a large stone stair-case. This temple is ornamented with vases, full of artificial flowers, and in it are musical instruments, such as we have already mentioned. The statue of this god is seen through a piece of black gauze, which forms a sort of veil or curtain before the altar. The rest of the pagoda consists of several large chambers; the gardens and pleasure-grounds are on the declivity of the mountain, and a number of delightful grottos are cut out in the rock, and afford an agreeable shelter from the excessive heat of the sun. There are several other pagodas in the island of Emoy; one of which is called the "Pagoda of 10,000 stones," which is built on the brow of a mountain, in which there is a like number of little rocks, under which the bonzes have formed grottos and pleasant covered seats. Grosier's China, vol. i.

**EMPALEMENT**, or **IMPALEMENT**, a cruel kind of punishment, whereby a sharp pale or stake, is thrust up the fundament and through the body.

The word comes from the French, *empaler*, or the Italian, *impalare*; or rather, they are all alike derived from the Latin, *palus*, a *stake*, and the preposition *in*, *in*, *into*.

We find mention of empaling in Juvenal. It was frequently practised in the time of Nero, and continues to be so in Turkey.

**EMPALEMENT**, or *Calyx*, in *Botany*, denotes the termination of the cortex, or outer bark of a plant; which, after accompanying the trunk or stem through all its branches, breaks out with the flower, and is present in the fructification in this new form. Its chief use is to enclose and protect the other parts. It has received different appellations, according to the circumstances that attend it; as *Porianthium*, or flower-cup, *Involucrum*, or cover, *Amentum*,

or catkin, *Spatha*, or sheath, *Glume*, or husk, *Calyptra*, or veil, and *Volva*, which see respectively. See **CALYX**.

**EMPAPELLING**, or **IMPANELLING**, in *Law*, signifies the writing and entering into a parchment schedule, or roll of paper, by the sheriff, the names of a jury summoned by him to appear for the performance of such public service as juries are employed in. See **JURY**.

**EMPARLANCE**, or **IMPARLANCE**, *Interlocutio*, or *licentia loquendi*, in *Law*, a desire, or petition, in court, of a day to consider, or advise, what answer the defendant shall make to the action of the plaintiff.

The civilians call it *petitio induciarum*. Kitchen mentions *emparlance general*, and *special*; the first seems to be only that made in one word, or in general terms without any special clause. This is of course where the defendant is not bound to plead the same term; and it is without saving to the defendant any exception, which is always to another term. It is granted to the defendant before he pleads by consent of the court; to see if he can end the matter amicably without farther suit, by talking with the plaintiff:—a practice, which is supposed (Gilb. Hist. Com. Pl. 55.) to have arisen from a principle of religion in obedience to that precept of the gospel "agree with thine adversary quickly, whilst thou art in the way with him." (Matt. v. 25.) It may be observed, that this gospel precept has a plain reference to the Roman law of the twelve tables, which expressly directed the plaintiff and defendant to make up the matter while they were in the way, or going to the prætor;—*in via, rem uti pacant orato*. *Emparlance special*, is where the party requires a day to deliberate, adding these words, "Salvis omnibus advantagiis tam ad jurisdictionem curiæ, quam ad breve et narrationem."

This *emparlance* is had on the declaration of the plaintiff; and it is of use where the defendant is to plead some matters, which cannot be pleaded after a general *emparlance*. (5 Rep. 75.) This special *emparlance* is with a saving of all exceptions to the writ or count which may be granted by the prothonotary; or they may be still *more special*, with a saving of all exceptions whatsoever, which are granted at the discretion of the court. (12 Mod. 529.)

*Imparlance* is generally to the next term; and if the plaintiff amend his declaration after delivered or filed, the defendant may imparl to the next term, if the plaintiff do not pay costs, but if he pay costs, which are accepted, the defendant cannot imparl. Also, if the plaintiff declares against the defendant, but doth not proceed in three terms after, the defendant may imparl to the next term. (2 Lill. Abr. 35.) If the writ be returnable on the last day of term, the defendant is of course entitled to an *imparlance*, but must plead in four days of the next term, provided a rule be given either in a town or country cause. On a declaration delivered of *Hilary*, there may be an *imparlance* to *Trinity* term, if the defendant has not pleaded before; for it is the course of the court to give *imparlance* or declaration till the day of pleading. If a writ be returnable in one term, and the declaration is not delivered before the essoign day of the second term, the defendant is not obliged to plead in the same term, but is entitled to an *imparlance*. (Impey, K. B.) The causes of *imparlance* are as follow. The not delivering a declaration in time is sometimes the cause of *imparlance* of course, and where the defendant's case requires a special plea, and the matter which is to be pleaded is difficult, the court will, upon motion, grant the defendant an *imparlance*, and longer time to put in his plea, than otherwise by the rules of the court he ought to have: if the plaintiff keeps any deed or other thing from the defendant, whereby he is to make his defence, *imparlance* may be granted till the plaintiff delivers

delivers it to him, or brings it into court, and a convenient time after to plead. (Hil. 22 Car. 1. B. R.) There are many cases in which imparlances are not allowed. No imparlance is granted in an *homine replegiando*; or in an assise, unless on good cause shewn; nor shall there be an imparlance in an action of special *clausum fregit*, though it is allowed in general actions of trespass. (Hil. 9 W. III. 3 Salk. 186.) Where an attorney, or other privileged person of the court sues another, the defendant cannot imparl, but must plead presently: if the plaintiff sues out a special original, wherein the cause of action is expressed, and the defendant is taken on a special *capias*, he shall not have imparlance, but shall plead as soon as the rules are out. (2 Lil. 35, 36.) In case of pleadings afterwards, a plea to the jurisdiction may not be pleaded after general imparlance. (Raym. 34.) Dilatory pleas cannot be pleaded after a general imparlance, which is an acknowledgment of the propriety of the action. After imparlance the defendant cannot plead in *abatement*; however, if it appear by the record that the plaintiff hath brought his action before he had any cause, the court *ex officio* will abate the writ. (2 Lev. 197.) Although a special imparlance shall not be allowed the defendant without leave of the court first obtained (R. E. 5 Ann.); yet if the writ be returnable before the last return of any term, and the declaration not filed, and notice given four days exclusive before the end of such term, the defendant is entitled to an imparlance, (R. Trin. 22 Geo. III.) Blackst. Com. vol. iii. Jacob's Law Dict. by Tomlins. Art. *Imparlance*.

Britton also uses imparlance for the conference of a jury upon a cause committed to them.

**EMPASMA**, *Εμπασμα*, from *εμπάσσω*, I sprinkle, in *Pharmacy*, a powder thrown or sprinkled over the body, to correct some ill smell thereof, or to prevent unnecessary sweats.

**EMPASTING**, or **IMPASTING**, a term used in *Painting*, for the laying on of colours thick and bold, or applying several lays of colours, so that they may appear thick. See **COLOURING**.

It is formed of the French, *empâster*, which has the same signification of *paste*, or *pâte*, *paste*.

A painting is said to be well empasted with colours, when the colours are bestowed plentifully, or it is well soaked, and saturated with colours.

The term is also used when the colours are laid distinct, and asunder, and not softened and lost in each other: *e. g.* this head is not painted, it is only empasted.

**EMPATTEMENT**, French, from *empâter*, to thicken, in *Fortification*, a term used by some to denote the same with talus.

**EMPEDOCLES**, in *Biography*, a native of Agrigentum, in Sicily, was a disciple of Telauges, a scholar of Pythagoras, and distinguished for his knowledge in every department of science and philosophy, as a poet, an orator, an historian, and a physician. He adopted the Pythagorean doctrine of the transmigration of souls, and wrote a poem on the subject, which the ancients have highly praised. He stated the history of the different changes which his own soul had undergone during its transmigrations, as follows; it commenced its career in the person of a girl, next appeared in that of a boy, afterwards it animated a shrub, then a bird, a fish, and lastly Empedocles. In the same poem, the title of which was, "On the Nature of Things," he explained his doctrine respecting the elements. He contended that "there were four of these elements, which are at continual war with each other, without the power of destroying each other; and that all bodies were produced

by this conflict." The fragments of his verses, which are dispersed through various ancient writers, have been, in part, collected by Henry Stephens. (In *Poesi Phil.* 1574, 8vo.) This circumstance affords some ground for the opinion of Fabricius, (*Bib. Græc. v. i. p. 466.*) that Empedocles was the real author of that ancient fragment, which bears the title of "The golden Verses of Pythagoras." From these fragments his philosophical opinions have been collected. Besides his hypothesis of four elements, the first material principles of which were indefinitely small, round, and similar atoms, he maintained, that it is impossible to judge of truth by the senses without the assistance of reason; which is led, by the intervention of the senses, to the contemplation of the real nature, and immutable essences, of things. The first principles of nature are of two kinds, active and passive; the active is unity, or God; the passive, matter. The active principle is a subtle, ethereal fire, intelligent and divine, which gives being to all things, and animates all things, and into which all things will be at last resolved. Many dæmons, portions of the divine nature, wander through the region of the air, and administer human affairs. Man, and also all brute animals, are allied to the divinity; and it is therefore unlawful to kill or eat animals. The world is one whole, circumscribed by the revolution of the sun, and surrounded, not by a vacuum, but by a mass of inactive matter. In the formation of the world, ether was first secreted from chaos, then fire, then earth; by the agitation of which were produced water and air. The heavens are a solid body of air, crystallized by fire. The stars are bodies composed of fire, they are fixed in the crystal of heaven; but the planets wander freely beneath it. The sun is a fiery mass, larger than the moon, which is in the form of a hollow plate, and twice as far from the sun as from the earth. The soul of man consists of two parts, the sensitive, produced from the same principles with the elements; and the rational, which is a dæmon sprung from the divine soul of the world, and sent down into the body as a punishment for its crimes in a former state, where it transmigrates till it is sufficiently purified to return to God.

The style of Empedocles, if we may believe the account of Aristotle, as quoted by Diogenes Laertius, very much resembled that of Homer; it was extremely energetic and enriched with metaphor, and every variety of poetical figure. His talents drew upon him the eyes of all Greece: his verses were sung at the Olympic games, with those of Homer, Hesiod, and the most famous poets; and at the games, and on all other public occasions, he is said to have been himself the most attractive part of the spectacle, so anxious were the people to behold him. He was greatly distinguished too as an orator, and is said to have been the first of the philosophers who gave lessons on rhetoric in Sicily. He usefully employed this talent of oratory in reforming the licentious manners of the Agrigentines, whom he reproached "for pursuing pleasures, with as much eagerness as if they were to die before to-morrow; and for building houses as if they believed that they should live for ever."

Empedocles was likewise celebrated as a physician, and wrote a poem "On Medicine," consisting of six hundred verses. In this work he is said to have boasted, that he was able not only to cure diseases, but also to drive away old age, and even to restore the dead to life; and to have intimated that the sick would hereafter invest him with divine honours. Pliny affirms that he succeeded in restoring a female, who had lain thirty days, without any signs of respiration: and

Paufanias, one of his disciples, and a physician, wrote a treatise respecting the disease and recovery of this woman, whom he termed *ἀπιος*. He was greatly skilled in music, which, after the example of Pythagoras, he employed as a remedy, not only against the diseases of the mind, but even against those of the body. Being lodged in the town of Gela, with his friend Auchitus, he was informed that a young man in a great rage was determined to kill this friend, who had sentenced his father to capital punishment. Empedocles endeavoured to calm his mind by persuasive discourse; but his eloquence producing no effect, he took his lyre, and combined its melodious sounds with the flowing numbers of poetry; and so employed the modulations, which made the greatest impression on the heart of the young man, that by degrees he was entirely softened, and afterwards became his constant disciple. As a physician, he is related to have been eminently serviceable to his country on many occasions. He paid great attention to meteorology, and not only predicted storms, but proposed remedies against their effects. He counteracted the blighting influence of the Etesian winds, by constructing walls in the narrow passages of the mountains, through which they blew, and occasioned sterility in the neighbouring land: hence, according to Jamblichus and Diogenes Lærtius, he was called *Alexanemos* and *Colyfanemos*, or repeller of the winds. Pliny relates that he allayed a pestilence at Agrigentum, by means of fumigation (*ignium suffitu*); and Plutarch mentions another instance, in which he suppressed a plague, which raged with extreme violence and fatality, by closing an aperture or chasm of the earth, in the vicinity of the mountains, from which he alone observed that pestilential effluvia issued.

For these various services to his country, the Agrigentines offered him the government; which he refused, preferring a philosophical tranquillity to regal honours. He is said, by some of his historians, to have been ever generous, humane, and moderate, and ready at all times to stand forth as the declared enemy of tyrants; and to have vigorously pursued all those who seemed to aspire at the sovereign power. An anecdote is handed down to us in confirmation of this fact. A citizen of Agrigentum having invited him home to supper, and the hour of the repast being arrived, he inquired why it was not served up; "because," said the host, "we wait for the minister of the council." At length this officer appeared, and he was made master of the feast; during which he gave himself so many insolent airs, that Empedocles began to suspect that some secret project was concerted between the master of the feast and his inviter, with a view to re-establish the tyranny. The suspicion was but too well founded. The philosopher next day citing the two persons before the council, they were condemned to death.

A very different character, however, is ascribed to Empedocles by many other writers. He is said to have conducted himself with the utmost pride and haughtiness towards his fellow-citizens, and to have aspired to divine honours; walking pompously about the country, and through the cities, habited like the gods, and seeking the plaudits of the people. He wore a golden crown on his head, with Delphic chaplets in his hands, and brazen sandals on his feet, and was clothed in a robe of purple and gold, his hair being long and flowing.

The accounts of his death are not less various and contradictory. Some authors affirm, that thinking to pass himself for a deity, and to persuade the people that he had been taken directly up into heaven, he ascended *Ætna* in the night, and threw himself head-long into the burning

crater of the mountain, imagining that his death would remain for ever concealed from mortals; but that the treacherous mountain threw up one of his brazen sandals, and thus exposed the folly of the visionary, who disdained to be thought man.

" — Deus immortalis haberi

Dum cupit Empedocles ardentem frigidus *Ætnam*  
Influit." Hor. Ars Poet. v. 465.

Others, however, admitting that he perished in mount *Ætna*, assert that, impelled by his passion for the study of nature, he resolved to examine the crater of that volcano, and that having ventured too far, he accidentally fell into the burning gulf. Some authors, again, have affirmed, that he broke his leg, by falling from a chariot, which brought on a disease that proved fatal. Others pretend that he terminated his own existence, some say by throwing himself into the sea, and some by strangulation with a rope: while others maintain that he died a natural death, at the age of 77 years. But the most commonly received opinion, notwithstanding these contradictions, is, that this philosopher, being extremely advanced in years, accidentally fell into the sea, and was drowned, about 44 years before Christ, or in the 84th Olympiad. Timæus relates, that, towards the close of his life, Empedocles went into Greece, and never returned, and on this account, the exact time and manner of his death remain unknown. According to Aristotle, he died at the age of 60 years. Some writers make a distinction between Empedocles the philosopher, and another who was a poet. Castellani, upon what authority we know not, states that Empedocles, the philosopher and poet, was the son of Meto, and grandson of Empedocles, who was an excellent poet.

A statue was erected to the memory of Empedocles at Agrigentum. See Castellani Vit. Medicor. Illust. Mângeti Bibliotheca Scriptor. Med. Haller. Bibl. Med. Pract. Dict. Historique. Brucker's Hist. Philos. by Enf. vol. i.

EMPERESS, EMPRESS, *Imperatrix*, the feminine of emperor; the wife or widow of an emperor; or a princess who is the supreme ruler of an empire in her own right.

EMPERESS, is also used in the *Ancient French Poetry*, for a particular kind of rhyme, thus denominated by way of excellence.

The "rhime emperiere" was a sort of crowned rhyme, wherein the syllable that made the rhyme was immediately preceded by two other like syllables of the same termination, which made a kind of echo, called the *triple crown*; and which, to the shame of the nation, (as some of their late authors express it,) their best ancient poets took for a wonderful beauty and excellence.

Fa. Mourgues, in his treatise on French poetry, gives us an instance very proper to raise contempt of the miserable taste of that age, which knew no way of expressing that the world is impure, and subject to change, so excellent, as by saying,

" Qu'es tu qu'un imonde, monde, onde."

EMPEREUR, CONSTANTINE, L', in *Biography*, a learned divine, was a native of Holland, where he took the degree of doctor of theology, and became distinguished in oriental literature and Jewish antiquities. He was professor of theology and Hebrew at Harderwyck during eight years, and then was appointed professor of Hebrew at Leyden in 1627. He died in 1648, a short time after he had been appointed theological professor at Leyden. He obtained the character of a zealous defender of the Christian religion,

religion, against the objections of the Jews. He was the friend of the most learned men of his age, *viz.* of Heinſius, Buxtorf, &c. and offered to ſuperintend an impreſſion of their Talmudical dictionary in Holland. His works were chiefly theological, and highly eſteemed by his contemporaries. *Moreri.*

EMPERICHORESIS. See CIRCUMINCESSION.

EMPEROR, as far as this word denoted formerly the head of the German empire. See GERMANY.

EMPEROR, *Imperator*, among the *Ancient Romans*, ſignified a general of an army; who, for ſome extraordinary ſucceſs, had been complimented with this appellation. It was emphatically beſtowed by the ſoldiers, when, on the field of battle, they proclaimed their victorious leader worthy of that title. When the Roman emperors aſſumed it in that ſenſe, they placed it after their name, and marked how often they had taken it. Thus Auguſtus having obtained no leſs than twenty famous victories, was as often ſaluted with the title emperor; and Titus was denominated emperor by his army, after the reduction of Jeruſalem. See AUGUSTUS and TITUS.

Afterwards it came to denominate an abſolute monarch, or a ſupreme commander of an empire; a Roman emperor, &c. In this ſenſe Julius Cæſar was called emperor, and the title deſcended with the dignity to Octavius Auguſtus, and the ſucceeding emperors.

In ſtrictneſs, the title emperor does not, and cannot add any thing to the rights of ſovereignty; its effect is only to give precedence and pre-eminence above other ſovereigns; and as ſuch, it raiſes thoſe inveſted with it to the ſummit of all human greatneſs.

The emperors, however, pretend, that the imperial dignity is more eminent than the regal; but the foundation of ſuch prerogative does not appear: it is certain, the greateſt, moſt ancient, and abſolute monarchs, as thoſe of Babylon, Perſia, Aſſyria, Egypt, Macedonia, &c. were called by the name of *kings*, in all languages, both ancient and modern. See KING.

It is diſputed, whether or not emperors have the power of diſpoſing of the regal title. It is true, they have ſometimes taken upon them to erect kingdoms; and thus it is that Bohemia and Poland are ſaid to have been raiſed to the dignity; thus alſo, the emperor Charles the Bald, in the year 877, gave Provence to Boſon, putting the diadem on his head, and decreeing him to be called *king*, “*Ut more priſcorum imperatorum regibus videretur dominari.*” Add, that the emperor Leopold erected the ducal Pruſſia into a kingdom, in favour of the elector of Brandenburg; and though ſeveral of the kings of Europe reſuſed for ſome time to acknowledge him in that capacity, yet by the treaty of Utrecht, in 1712, they all concurred.

In the Eaſt, the title and quality of emperor are more frequent than they are among us; thus, the ſovereign princes of China, Japan, Mogul, Perſia, &c. are all emperors of China, Japan, &c.

In the year 1723, the czar of Muſcovy aſſumed the title of emperor of all Ruſſia, and procured himſelf to be recognized as ſuch by moſt of the princes and ſtates of Europe. See RUSSIA.

In the Weſt, the title has been a long time reſtrained to the emperors of Germany. The firſt who bore it was CHARLEMAGNE, who had the title emperor conferred on him by pope Leo III. though he had all the power before. His empire, however, was of no long duration. When the German branch of his family became extinct, the Germans exerciſed the right inherent in a free people, and, in a general aſſembly of the nation, elected Conrad count of

Franconia emperor. After him Henry of Saxony, and his deſcendants, the three Othos, were placed, in ſucceſſion, on the imperial throne, by the ſuffrages of their countrymen: the extenſive territories of the Saxon emperors, their eminent abilities, and enterpriſing genius, not only added new vigour to the imperial dignity, but raiſed it to higher honour and pre-eminence. (See OTHO.) But while the emperors, by means of new titles and new dominions, gradually acquired additional authority and ſplendour, the nobility of Germany went on at the ſame time extending their privileges and juriſdiction. Upon the whole, the imperial prerogatives were formerly much more extenſive than they are at preſent. At the cloſe of the Saxon race, A.D. 1024, they exerciſed the right of conferring all the great eccleſiaſtical benefices in Germany; of receiving the revenues of them during a vacancy; of ſucceeding to the effects of inteſtate eccleſiaſtics; of confirming or annulling the elections of the popes; of aſſembling councils, and of appointing them to decide concerning the affairs of the church; of conferring the title of king on their vaſſals; of granting vacant ſiefs; of receiving the revenue of the empire; of governing Italy as its proper ſovereigns; of erecting free cities, and eſta bliſhing fairs in them; of aſſembling the diets of the empire, and fixing the time of their duration; of coining money, and conferring the ſame privilege on the ſtates of the empire; and of adminiſtering both high and low juſtice within the territories of the different ſtates. But in the year 1437, at the period of the extinction of the emperors of the families of Luxemburgh and Bavaria, they were reduced to the right of conferring all dignities and titles, except the privilege of being a ſtate of the empire; of *preces-primaria*, or of appointing once during their reign a dignitary in each chapter, or religious houſe; of granting diſpenſations with reſpect to the age of majority; of erecting cities, and conferring the privilege of coining money; of calling the meetings of the diet, and preſiding in them.

In the one period, the emperors appear as mighty ſovereigns, with extenſive prerogatives; in the other, as the heads of a confederacy, with very limited powers. The revenues of the emperors decreaſed ſtill more than their authority. The early emperors, particularly thoſe of the Saxon line, beſides their vaſt patrimonial or hereditary territories, poſſeſſed an extenſive domain both in Italy and Germany, which belonged to them as emperors. Italy belonged to the emperors as their proper kingdom; and the revenues which they drew from it were very conſiderable. But the firſt alienations of the imperial revenue were made in this country. The Italian cities, having acquired wealth, and aſpiring at independence, purchaſed their liberty from different emperors. Many diſtricts, poſſeſſed by the emperors, which were intermixed with the eſtates of the dukes and barons, were ſeized by the nobles, during the conteſts that took place between the emperors and the court of Rome. The emperors were alſo almoſt entirely robbed of their caſual revenues; the princes and barons appropriating to themſelves taxes and duties of every kind, which had been uſually paid to them. From the reign of Charles IV., whom Maximilian called the peſt of the empire, the emperors were reduced to the neceſſity of depending entirely on their hereditary dominions, as the only ſource of their power, and even of their ſubſiſtence. Pfeffel Abregé de l'Hiſt. d'Allem.

One principal cauſe of the degradation of the emperors was the aggrandizement of the clergy. The popes, before the firſt period above mentioned, A.D. 1024, had been dependent on the emperors, and indebted for their power

as well as dignity to their beneficence and protection. But they afterwards began to claim a superior jurisdiction; and in virtue of authority, which they pretended to derive from heaven, tried, condemned, excommunicated, and deposed their former masters. Pope Gregory VII. combined political discernment and sagacity with his presumption and violence; and commenced his rupture with Henry IV. upon a pretext that was popular and plausible. He complained of the venality and corruption with which the emperor had granted the investiture of benefices to ecclesiastics. All the censures of the church were denounced against Henry; and the most considerable of the German princes and ecclesiastics were excited to take arms against him. So successful was the court of Rome in inflaming the superstitious zeal, and conducting the factious spirit of the Germans and Italians, that an emperor, distinguished not only for many virtues, but possessed of considerable talents, was at length obliged to appear as a supplicant at the gates of the castle in which the pope resided, and to stand there three days, bare-footed, in the depth of winter, imploring a pardon, which was at length obtained with difficulty. This act of humiliation degraded the imperial dignity. Nor was the depression momentary. The contest between Gregory and Henry gave rise to the two powerful factions of the Guelfs and Ghibellines; the former of which supporting the pretensions of the popes, and the latter defending the rights of the emperor, kept Germany and Italy in perpetual agitation during three centuries. A regular system for humbling the emperors, and circumscribing their power, was formed and uniformly adhered to during that period. The decline of the imperial authority may partly be ascribed to the change which took place with regard to the mode of their election. During a long period, all the members of the Germanic body assembled, and chose the person whom they appointed to be their head; but amidst the violence and anarchy which prevailed for several centuries in the empire, seven princes, who possessed the most extensive territories, and who had obtained an hereditary title to the great offices of the state, acquired the exclusive privilege of nominating the emperor. This right was confirmed to them by the golden bull; the mode of exercising it was ascertained; and they were dignified with the appellation of *Electors*. These electors, by their extensive power, and the distinguishing privileges which they possessed, became formidable to the emperors, with whom they were placed almost on a level in several acts of jurisdiction. See *ELECTOR*, and *DIET*.

To the privileges and powers formerly belonging to the emperors, and which have been above enumerated, some have added, 1. That all the princes and states of Germany are obliged to do them homage, and swear fidelity to them. 2. That they, or their generals, have a right to command the forces of all the princes of the empire, when united together. 3. That they receive a kind of tribute from all the princes and states of the empire, for carrying on a war which concerns the whole empire, which is called the *Roman month*. As to the present mutilated state of the German empire, see *ELECTOR* and *GERMANY*.

The kings of France were anciently also called emperors, at the time when they reigned with their sons, whom they associated to the crown: thus, Hugh Capet having associated his son Robert, took the title of emperor, and Robert that of king; under which titles they are mentioned in the history of the council of Rheims, by Gerbert, &c. King Robert is also called emperor of the French, by Helgau of Fleury. Lewis le Gros, upon associating his son, did the same. In the first register of the King's

Charters, fol. 166, are found letters of Louis le Gros, dated in 1116, in favour of Raymond, bishop of Maguelonne, wherein he styles himself "Ludovicus, Dei ordinante providentia, Francorum imperator Augustus." The kings of England had likewise anciently the title of emperors, as appears from a charter of king Edgar: "Ego Edgarus Anglorum basileus, omniumque regum insularum oceani quæ Britanniam circumjacent, &c. imperator & dominus."

We also say the king of England, "Omnem habet potestatem in regno suo quam imperator vindicat in imperio:" whence the crown of England has been long ago declared in parliament to be an imperial crown.

*EMPEROR*, among *Hebrew Grammatians*, is an appellation given to a species of accents serving to terminate a sense completely, and answers to our point. See *ACCENT*.

*EMPEROR* *Bleß*. See *ELECT*.

*EMPETRON*, in *Botany*, a name by which some authors, as Dodonæus, &c. have called the kali or glass wort. Ger. Emac. Ind. 2. See *KALI*.

*EMPETRUM*, from *εμ*, in or upon, and *πετρος*, a rock, or stone, expressing its stony barren places of growth. Linn. Gen. 515. Schreb. 676. Sm. Fl. Brit. 1072. Mart. Mill. Dict. v. 2. Juss. 162. Gært. t. 106. Class and order, *Diocia Triandria*. Nat. Ord. *Ericis affine*, Juss.

Gen. Ch. Male. Cal. Perianth in three deep, ovate, permanent divisions. Cor. Petals three, sometimes more, ovate-oblong, contracted at their base, larger than the calyx, withering. Stam. Filaments three, sometimes nine, capillary, very long, pendulous; anthers erect, short, deeply cloven.—Female. Cal. and Cor. as in the male. Pist. Germen superior, depressed; style short, simple; stigma nine, spreading, a little reflexed. Peric. Berry orbicular, depressed, of one cell, larger than the calyx. Seeds three or nine, ranged circularly, gibbous at the outer edge, angular at the other. The flowers are commonly dioecious, but sometimes the two sexes are found on the same plant, and even both organs united in one flower.

Ess. Ch. Male. Calyx deeply three-cleft. Petals three. Stamens capillary, from three to nine. Female, Calyx deeply three-cleft. Petals three. Stigmas nine. Berry superior, with three to nine seeds.

The species are two.

1. *E. album*. Linn. Sp. Pl. 1450. (*Erica coris folio decima*; Clus. Hist. v. 1. 45. *E. baccifera tenuifolia*; Ger. em. 1381.) "Stem erect." Observed by Clusius on sandy heaths near Lisbon, bearing fruit early in November. He compares the berries, which are white, acid, and transparent, to pearls of an inferior kind. He generally found but three seeds in each, which accords with Gærtner's account of this species. The stems are shrubby, a foot and half high, erect, branched in a determinate order. Leaves ternate, evergreen, linear, obtuse, revolute, smooth above, resembling those of many heaths. Flowers not observed. Berries lateral, solitary, the size of a moderate pea, resembling those of *Mistletoe*.

2. *E. nigrum*. Linn. Sp. Pl. 1450. Sm. Fl. Brit. 1072. Engl. Bot. v. 8. t. 526. (*E. montanum, fructu nigro*; Raii Syn. 444. *Erica baccifera procumbens*; Ger. em. 1383.) "Stems procumbent." Black Crow-berry, or Crane-berry. Plentiful on mountainous heaths in the north of England, as well as in Sweden, Lapland, Denmark, &c. blossoming in May, and ripening fruit in August. It differs from the former in its more humble and procumbent growth, and in having black berries, with nine seeds. Flowers reddish, axillary, plentiful about the tops of the last-year's branches. The fruit has a mild flavour of elderberries,

berries, and "affords sustenance to ptarmigans, grouse, partridges, and even to the hardy highlander himself."

EMPHASIS, in *Elocution*, a term generally, but absurdly, used by modern writers, exclusively in the singular number. "Emphasis," says Mr. Sheridan (Lecture iv.), "discharges in sentences the same kind of office that accent does in words. As accent is the link which ties syllables together, and forms them into words; so emphasis unites words together, and forms them into sentences, or members of sentences. As accent dignifies the syllable on which it is laid, and makes it more distinguished by the ear than the rest; so emphasis ennobles the word to which it belongs, and presents it in a stronger light to the understanding. Accent is the mark which distinguishes words from each other, as simple types of our ideas, without reference to their agreement or disagreement. "Emphasis is the mark which points out their several degrees of relationship," and the rank which they hold in the mind. Accent addresses itself to the ear only; emphasis, through the ear, to the understanding. Were there no accents, words would be resolved into their original syllables: were there no emphasis, sentences would be resolved into their original words. And in this case, the hearer must be at the pains himself, first, of making out the words, and afterwards their meaning: and as this could not be done, without such length of pauses at the end of sentences, and their several members, as would allow him time to revolve in his memory the sounds which have been uttered, it would make the action of listening to discourse laborious and disgustingly tedious. Whereas, by the use of accent and emphasis, words, and their meaning, being pointed out by certain marks, at the same time that they are uttered, the hearer has all trouble saved, but that of listening; and can accompany the speaker at the same pace that he goes, with as clear a comprehension of the matter offered to his consideration as the speaker himself has if the speaker delivers himself well."

It is not very easy to discover what Mr. S. means, (even with his interpretation of the word accent,) when he says, that "were there *no accent*, words would be resolved into their *original syllables*;" since monosyllables, though denied the property of what is here called accent, are nevertheless admitted by Mr. S. and the grammarians in general to be words; and since, as will be shewn hereafter, the ear alone (unassisted by the memory of impressions received through the eye) has even yet (with all the assistance derived from that *poise* and that *percussion* of particular syllables, so absurdly confounded in the popular abuse of the term accent) no possible means of distinguishing polysyllabic words from successive monosyllables, when properly pronounced. Certainly he is not at all more intelligible, when he adds, "were there *no emphasis*, sentences would be resolved into their *original words*;" or again, when he informs us, that "by the use of accent and emphasis, *words, and their meaning*, are pointed out by certain marks, *at the same time* that they are uttered." That shifting the percussion, or varying the poise of similar associations of syllables, will essentially change the meaning even of words in their separate capacity, (as *disser, deser; désert, desért; présent, présént; refusé, refúsé; objet, objét; incense, incensé*, &c. see B. Jonson's Gram.) and still more of such associated syllables as may occasionally be brought together in the composition of sentences, must be readily allowed; and that the sense of *all sentences* would be much obscured by the omission, and of *many* entirely inverted by a transposition of the emphases: but still the words, as words, and their meanings as words, (though not their specific re-

lations to the other words of the sentence,) would be recognized "at the same time they were uttered," whether they were accompanied with emphases or not: and as for what is here misnamed the accent, the *poise* at least must of physical necessity be somewhere placed; and *speech* without it could not be conducted at all. But Mr. S. never seems to have dreamed of submitting either the process or the nomenclature of elocution to physiological or critical analysis. He used the terms of his art as he found them in the works of the grammarians and rhetoricians of modern times; and as their phraseology was all confusion and contradiction, his elucidations were not likely to be very satisfactory. The Lecture on Emphasis, however, is by far the most valuable portion of this work.

"The necessity of observing propriety of emphasis," says he, "is so great, that the true meaning of words cannot be conveyed without it. For the same individual words, ranged in the same order, may have several different meanings, according to the placing of the emphasis. Thus, to use a trite instance, the following sentence may have as many different meanings as there are words in it, by varying the emphasis: "Shall you ride to town to-morrow?" If the emphasis is on *shall*, as, *Shall* you ride to town to-morrow? it implies, that the person spoken to had expressed before such an intention, but that there is some doubt in the questioner whether he be determined on it or not; and the answer may be, Certainly, or, I am not sure. If it be on *you*, as, *Shall you* ride to town to-morrow? the question implies that some one is to go, and do you mean to go yourself, or send some one in your stead? and the answer may be, No, but my servant shall. If on *ride*, as, *Shall you ride*, &c.? the answer may be, No, I shall walk, or go in a coach. If on *town*, as, *Shall you ride to town* to-morrow? the answer may be, No, but I shall ride to the forest. If on *to-morrow*, as, *Shall you ride to town to-morrow*? the answer may be, No, not to-morrow, but the next day."

These observations and illustrations may serve to shew the importance of emphases in general; but they do nothing towards illustrating the specific characteristics of such emphases. Indeed, in all that Mr. S. has said upon this subject, it should seem as if he had no clear conception of any other species of emphasis, than the emphasis of force; and it is evident, indeed, that the conceptions of the generality of readers and reciters, practically, go no farther. Mr. S. does indeed say, in another place, "that emphasis is of two kinds," (surely, then it should have been that emphases are of two kinds,) "simple or complex. Simple, when it serves only to point out the plain meaning of any proposition; complex, when, besides the meaning, it marks also some affection or emotion of the mind; or gives a meaning to words, which they would not have in their usual acceptation, without such emphasis. In the former case, emphasis is little more than a stronger accent, with but little change of tone; when it is complex, besides force, there is always superadded a manifest change of tone. Simple emphasis belongs to the calm and composed understanding; complex, to the fancy and the passions." But the concluding remark sufficiently evinces how little the nature of these varieties was understood by this author, and how imperfectly the terms of his art were defined in his own mind; for it will presently be shewn, that even without any necessity of appeal to the fancy and the passions, a much more complex system of emphases is necessary fully to elicit, and agreeably to illustrate, the sense of many passages. Mr. Cockin, in his "Art of delivering written Language," animadvert upon the want of clearness in this distinction, and upon

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the apparent confusion between the significant power of emphasis and the various "tones, simply considered, of all the emotions of the mind;" and seems to imagine he has remedied the confusion by contradistinguishing emphases into "emphasis of sense, and emphasis of force;" and Mr. Walker, (*Elements of Elocution*, p. 190.) considers this distinction as having "thrown great light upon this abstruse subject." But as the emphasis of force is most assuredly as indispensable to the full expression of the sense, as any of the other *several* species of emphases, it is very questionable whether this pretended distinction does any thing more than render confusion worse confounded. Mr. Cockin proceeds; "now from the above account of these two species of emphasis it will appear, that in reading, as in speaking, the first of them will be determined entirely by the sense of the passage, and always made alike: but as to the other, taste alone seems to have a right of fixing its situation and quantity." Farther, "since the more essential of these two energies is solely the work of nature, (as appears by its being constantly found in the common conversation of people of all kinds of capacities and degrees of knowledge,) and the most ignorant person never fails of using it rightly in the effusions of his own heart, it happens very luckily, and ought always to be remembered, that provided we understand what we read, and give way to the dictates of our own feeling, the emphasis of sense can scarce ever avoid falling spontaneously upon its proper place." That mere taste has any thing to do with fixing the *situation* of the emphasis of force (whatever it may have to do with its *quantity* or *degree*) we utterly deny; or that, in just reading or recitation, it can be determined by any thing but the *sense* alone. And as for what is said of even the most ignorant person never failing, in common conversation and the effusions of his own heart, in the right application of the *emphasis of sense*, it is true of all the kinds of emphases; for, in spontaneous speaking, all emphases are emphases of sense; and in all other kinds of speaking (reading or reciting) whatever emphases are not so, must be emphases of nonsense. Mr. Walker, indeed, has himself suggested a much more rational species of distinction, and has made some considerable advances towards a just system or theory upon this subject, by drawing a clear line of demarcation between what, perhaps, might very properly have been called the inherent or *grammatical powers* of particular classes of words, and the arbitrary or *significant emphases* of specific words in a sentence. Perhaps had Mr. W. so denominated them, not only his distinctions, so far as they go, might have been rendered more obvious, but the denomination itself would have led him to discover that there are still distinct species of actual emphases, properly so called, which have escaped his observation. He would not then, perhaps, have told us, that "emphasis, in the most usual sense of the word, is that stress with which certain words are pronounced, so as to be distinguished from the rest of the sentence." He would have perceived that such a definition was much too vague to meet even the full signification of the term in popular usage: for no one does in reality apply the term emphasis to the mere grammatical or inherent force that distinguishes, in all distinct and intelligible spontaneous speech, the nouns and verbs above the articles, conjunctions, and prepositions. The term, on the contrary, always supposes some superadded distinction given to a word or words of what description soever, and conferring upon such words a degree of importance in the sentence, beyond what is inherent in their mere grammatical quality. Mr. W. proceeds, "among the number of words we make use of in discourse, there will always be some which are more necessary to be

understood than others: those things with which we suppose our hearers to be pre-acquainted (he might have added, 'or which are necessary only for the mere grammatical connection of the more important words,') we express by such a subordination of stresses as is suitable to the small importance of things already understood; while those of which our hearers are either not fully informed, or which they might possibly misconceive, are enforced with such an increase of stress, as makes it impossible for the hearer to overlook or mistake them. Thus, as in a picture, the more essential parts of a sentence are raised, as it were, from the level of speaking; and the less necessary are, by this means, sunk into a comparative obscurity." This is both just and pertinent, and the simile at the conclusion is even more apposite, than Mr. Walker seems himself to have been aware; for, to pursue the metaphor in elocution as in picture, it is not merely by the force of a line or the depth of a shadow, that all the varieties of emphatic effect are to be expected to be produced. "From this general idea of emphasis," continues Mr. W., "it will readily appear of how much consequence it is to readers and speakers not to be mistaken in it; the necessity of distinguishing the emphatical words from the rest, has made writers on this subject extremely solicitous to give such rules for placing the emphasis as may, in some measure, facilitate this difficult part of elocution; but few have gone farther than to tell us that we must place the emphasis on that word in reading which we should make emphatical in speaking; and though the importance of emphasis is insisted on with the utmost force and elegance of language, no assistance is given us to determine which is the emphatic word, where several appear equally emphatical, nor have we any rule to distinguish between those words which have greater, and those which have a lesser degree of stress; the sense of the author is the sole direction we are referred to, and all is left to the taste and understanding of the reader."

He then proceeds to state with high commendation the above-mentioned distinction of Mr. Cockin, whose definition he quotes as follows: "Emphasis of force," he tells us, "is that stress we lay on almost every significant word: emphasis of sense is that stress we lay on one or two particular words, which distinguishes them from all the rest of the sentence. The former stress," he observes, "is variable, according to the conception and taste of the reader, and cannot be reduced to any certain rule: the latter," he says, "is determined by the sense of the author, and is always fixed and invariable. This distinction, it must be owned," continues Mr. Walker, "is, in general, a very just one, and a want of attending to it has occasioned great confusion in this subject, even in our best writers. Thus, when the emphatical words were to be marked, by being printed in a different character, we find in several of the modern productions on the art of reading, that sometimes more than half of the words are printed in italics, and considered as equally emphatical. The wrong tendency of such a practice," continues Mr. W., "was never pointed out till the publication of the essay above-mentioned;" by the assistance of which Mr. W. professes to endeavour to push his inquiries still farther; "not only to establish the distinction he has laid down, but to draw the line between those two kinds of emphasis, so as to mark more precisely the boundaries of each. To this distinction of emphasis he accordingly adds another, making a distinction of each into two kinds, according to the inflexion of voice they adopt; which, though of the utmost importance in conveying a just idea of emphasis, had never been noticed by any of our writers on the subject." The distinction thus added is

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that which relates to the application of the rising and falling inflexion, and which, though in reality such inflexions apply not only to emphatic words, but in a smaller or greater degree to all the words and syllables of which language, properly delivered, is composed, (every syllable not delivered in a *monotone*, *i. e.* not lung, having of necessity either an acute, a grave, or a circumflex accent,) is assuredly a distinction of much importance, in what relates to the practical adjustment of the emphasis, and for the comprehension of Mr. Walker's theory, relative to which (imperfect as that theory, perhaps, may be) the student will do well to refer both to the "Elements" and to the "Rhetorical Grammar" of that elaborate professor. "This," says Mr. W., "brings us to a threefold distinction of words, with regard to the force with which they are pronounced; namely, the conjunctions, particles, and words understood, which are obscurely and feebly pronounced; the substantives, verbs, and more significant words, which are firmly and distinctly pronounced; and the emphatical word, which is forcibly pronounced: it is the last of these only which can be properly styled emphasis; and it is to a discovery of the nature and cause of this emphasis that all our attention ought to be directed. And first, we may observe, that if these distinctions are just, the common definition of emphasis is very faulty. Emphasis is said to be a stress laid on one or more words to distinguish them from others: but this definition, as we have just seen, makes almost every word in a sentence emphatical."

Mr. W. then adds, "the principal circumstance that distinguishes emphatical words from others, seems to be a meaning which points out, or distinguishes, something as distinct or opposite to some other thing. When this opposition is expressed in words it forms an antithesis, the opposite parts of which are always emphatical. Thus, in the following couplet from Pope:

'Tis hard to say, if greater want of skill  
Appear in writing or in judging ill.

The words *writing* and *judging* are opposed to each other, and are therefore the emphatical words.

But this describes only the emphasis of antithesis, which is certainly not the only species of emphasis, properly so called, that is requisite to well delivered speech; for words are rendered important by apposition, as well as by opposition; by their relative, and their absolute consideration in the sentence, and by their reflective, as well as their antagonistic meaning, and to ascertain and exemplify all the varieties and circumstances of emphases, were almost to illustrate the whole theory of the actual and practicable melody of speech. The threefold distinction above quoted does, however, furnish a clue to a part of this mazy labyrinth; and Mr. W.'s concluding definition, though imperfect, as excluding some essential classes of emphases, is strictly applicable to the full extent of his view, which was certainly the most comprehensive that had then been taken of the subject. "Emphasis," says he, "when applied to particular words, is that stress we lay on words, which are, in contradistinction to other words, either expressed or understood. And hence will follow this general rule; wherever there is contradistinction in the sense of the words, there ought to be emphasis in the pronunciation of them; the converse of this being equally true, wherever we place emphasis we suggest the idea of contradistinction." Now though it is not true, that all emphasis has an antithesis, either expressed or understood, yet as the emphases of antithesis constitute a very large and material class of these rhetorical distinctions, the following rules may be regarded as highly important. "If the em-

phasis excludes the antithesis, the emphatic word has the falling inflexion; if the emphasis does not exclude the antithesis, the emphatic word has the rising inflexion. The grand distinction, therefore, between the two emphatic inflexions is this; the falling inflexion affirms something in the emphasis, and denies what is opposed to it in the antithesis; while the emphasis with the rising inflexion, affirms something in the emphasis without denying what is opposed to it in the antithesis; the former, therefore, from its affirming and denying absolutely, may be called the strong emphasis; and the latter from its affirming only, and not denying, may be called the weak emphasis."

They who pursue Mr. W. through all his distinctions of simple, double, and triple emphasis, will undoubtedly, upon the whole, be much edified, though even with respect to the application of the inflexions they may not agree with him in every instance. But if Sheridan attempted nothing more than a practical elucidation of the application and misapplication of emphasis, without laying down any general principles, or rules of extensive and perspicuous application, or discriminations of the characteristic varieties of emphases; and if Cockin only suggested without properly defining the differences between the grammatical import, and the emphatic distinction of words; Mr. W. while he has in some instances well defined the principle of the application of the rising, and the falling inflexions to emphatic words, has left it to more recent discovery to define, and to classify the several species of emphases, (properly so called,) and to point out the distinct properties, or actions both of the voice and the enunciation by which those species are to be contradistinguished. "All emphases," it is maintained by the lecturer on the science and practice of elocution, "affect the words upon which they fall in the three predicaments, of time, of tune, and of force, but as some species of emphases require a preponderancy of one, and other species of another of these properties, emphases may properly be contradistinguished into three kinds; emphasis of time, or the condition of words rendered emphatical, by the increased quantity assigned to the respective syllables; emphasis of tune, or the condition of words rendered emphatical, by the distinction of a superior degree of inflexion, or by a higher or lower pitch in the musical scale; and emphasis of force, or the condition of words rendered emphatical by the superior energy with which they are uttered. And the adjustment of these respective varieties of emphases, to their respective occasions, it is contended, is of equal importance with the selection of the proper situations for placing an emphasis at all; since the sense may be as completely perverted, or at least the ear may be as much shocked by inserting the emphasis of force (a very common error in theatrical recitation,) where that of tune, or of quantity was required, as by placing it altogether on a wrong word. To elucidate this system satisfactorily, would require more space than can conveniently be spared, in a general dictionary of the circle of sciences; but as there at present exists no printed copy of the lectures in question, nor any book upon the subject to which the student can be referred, part of a column will not perhaps be misapplied, by being devoted to the subject. The kinds of emphases enumerated are principally as follows. 1. The objective emphasis, or emphasis of import, *i. e.* the stress of voice by which proportionate importance is given to the word or words, conveying the substantive matter, or leading object of the sentence, as "I am desirous of being acquainted with *the nature of Man*." That is to say, "the nature of man is a subject to which I am desirous of directing some enquiry;" an idea which may be expressed either with or without any

reference to any other subject, either as associated or rejected. In which latter case, no antithesis is either expressed or implied, and the simple emphasis of import is expressed, by an increased stress of the voice, thrown upon the whole of the syllables, composing the amalgamated substantive, or compound name of that object, to wit, "the nature of man." 2. Emphasis of antithesis, or that characteristic stress and inflexion of the voice by which the opposition between two ideas, or parts of a compound idea, is pointed out, and emphatically impressed upon the mind. The antithesis may be either expressed or understood. Thus, if the preceding passage be requested with an emphasis upon the word *nature* only, and that emphasis be principally specified by a strong circumflexive accent (that is to say, by a partial increase of quantity and a specific peculiarity of time) I am desirous of becoming acquainted with the *nature* of Man;—the words have changed to a certain degree their signification; an antithesis is understood; and the interpretation becomes "It is not the *history*—it is not the outward *form* and *complexion*, or any other particular incident relative to man, but his general nature, his physical and moral attributes that I am desirous of knowing." Again, if the single word *Man* be rendered emphatic by superadding to the customary energy of the closing poise or final heavy syllable a certain portion of the same species of time, "I am desirous of becoming acquainted with the nature of *man*," will then by another implied antithesis come to signify, "It is not with the nature of stones, and earths, and shrubs, and herbs, and brute animals, that I am desirous of becoming acquainted, but with that of man." Of the direct or expressed antithesis we have an illustration in the following sentence. "It is not with the nature of *Man*, but with the nature of *God*, that I am desirous of being acquainted." Upon this species of emphasis little need be added to what has already been said by Mr. Walker. 3. The emphasis of coincidence, or the level and equal stress of the voice upon two or more words either in the same or different members of a sentence; by which the relationship, agreement, and equal importance of the annexed ideas are indicated: as—"The *stature*, the *form*, and the *complexion* of man, as well as his *moral* and *physical* attributes are parts of his nature; and his *history* must be studied that his nature may be understood." In this instance all the words distinguished by italics demand the emphasis of coincidence: a species of emphasis which is expressed more by its time, or quantity, than either by its inflexion or its force. As this is the species of emphasis that is least obtrusive, it is that which may be used with the greatest frequency and freedom. 4. Complicated emphases. Sometimes all the different kinds of emphases are mingled in one sentence; so that several different words, or pairs of words, require to be discriminated in all the varieties and degrees of time, tune, and force. "It is not the *NATURE* of *Man* that I am desirous of *STUDYING*; but the *LAWS* of *God* that I am *anxious* to *COMPREHEND*." Here *NATURE*, *LAWS*; *Man*, *God*; *desirous*, *anxious*; *STUDYING*, *COMPREHEND*, require to be respectively balanced and coupled in the mind by appropriate responses of quantity, tune, and force; which if the sentence flowed spontaneously would as spontaneously be adjusted in all propriety, but the due application and apportioning of which to written language constitutes one of the most difficult parts of the art of reading.

There is one thing more which it is necessary to observe on the subject of emphasis, and then we have done with this long article. It has been mistakenly supposed, that the distinction of emphasis necessarily belongs to single

words; nay some there are, who, confounding emphasis with mere percussive, would confine it to single syllables; but the fact is, that emphasis (properly so called) belongs not either to the syllabic separation, or grammatical structure of words, but to the idea; and whether the substantive idea be expressed by a simple or by a compound name, the *whole* name of that idea, not a part only of that name, must bear the equal impress of that emphasis:—thus, for example, in the famous reply of the first William Pitt to Mr. Walpole,—“But youth it seems is not my only crime; I have been accused of acting a theatrical part.” Here neither the word *acting*, nor the word *theatrical*, nor the word *part*, taken separately, designates the jut of the accusation, or constitutes the name of the idea included in the accusation: for if we read, “I have been accused of *acting* a theatrical part,” placing the emphasis only on the word *acting*; may it not properly be asked—Why, what would you do with a theatrical part but *act it*? If the emphasis be placed on *theatrical*, “I have been accused of acting a *theatrical* part?”—what part should be *acted*, but one that is *theatrical*?—if upon the word *part* alone—I have been accused of acting a theatrical *part*?—what that is theatrical can be acted but a *part*? The whole latter member of the sentence constitutes therefore the jut or object of the accusation.—“I have been accused?”—(of what?)—*of acting a theatrical part!*” These words therefore constitute, accordingly, the amalgamated substantive, or compound name of the indivisible, accusatory idea, and must receive throughout an equal portion of *objective emphasis*. Not that the syllables are thereby to be rendered equally forcible, or to be otherwise reduced to one monotonous level. They are only to receive one common superaddition of emphatic force; and as independently of such superaddition, they would have differed among themselves in pause, quantity, accent, and grammatical, or inherent force; in all those particulars they will still continue to differ.

Such is the present state of discovery and ascertainment to which enquiries had been conducted upon the subject of emphasis: by which it should seem, that it constitutes an essential part of the theory and practice of the melody of speech; to which we refer the reader; concluding the present article with the following definition. “Emphases consist in the superadditional importance given to particular words or parts of a sentence, by an increased stress, tune, quantity, or force in the pronunciation of such words or parts of a sentence; and by which their relative importance is pointed out, and the contrasts and assimilations of different members of a description, argument, or position, are discriminated to oral perception.” Whether it be possible, or even desirable that a system of notation (the want of which is lamented by Sheridan and others) should be invented and applied to the indication of these varieties, is a question that may belong to the article *NOTATION*; but which shall not be here discussed.

*EMPHATICAL*, is used by the *Ancient Philosophers*, to express those apparent colours which are often seen in clouds before the rising or after the setting of the sun; or those in the rainbow, &c.

These, because they are not permanent and lasting, they will not allow to be true colours; but, since these emphatical colours are light modified chiefly by refractions and with a concurrence of reflections, and some other accidental variations; and since they are the proper objects of sight, and capable as truly to affect it as other permanent colours are, there is no reason for excluding them from the number of true and genuine colours, since all other colours are only modifications of light, as these are.

**EMPHEREPYRA**, in *Natural History*, a genus of siderochita, composed of various crusts or coats, surrounding a nucleus of the same matter and structure with themselves. See **SIDEROCHITA**.

Of this genus we have five species. Hill's Hist. Fossils, p. 532.

**EMPHRACTIC**, in *Pharmacy*, the same with *emiplastic*. The word is formed from the Greek *εμψρακτιω*, I stop.

**EMPHRAXIS**, in *Medicine*, an obstruction in any part.

**EMPHRUE**, in *Botany*, the name given by the people of Guinea to a species of tree, the leaves of which they boil in wine, and give as a great restorative in cases of weakness and decay. Its leaves are exactly of the shape of those of the common mulberry, but they are not indented at the edge. Petiver has thence called it "arbor Guineensis mori folio non crenato." Phil. Trans. N<sup>o</sup> 232.

**EMPHYSEMA**. The common meaning of this word, in *Surgery*, is an inflation of the texture parts, in consequence of air getting out of a breach in the lungs, and passing into the communicating cavities of the cellular substance on the outside of the chest, through another breach existing at the same time in the pleura costalis, or membrane lining the thorax. However, there are some less frequent cases of emphysema, which are not comprehended in the preceding definition, as will be explained in the course of the present article. The term is derived from the Greek *εμψυσαι*, to inflate. Dr. Halliday, in a late ingenious essay on the subject under consideration, describes the following as the symptoms of an emphysema, when the affection proceeds from an injury of the thorax. A constant pain takes place in the side, that has been hurt. At first, the suffering is not increased even by a very full inspiration; but, no great length of time elapses, before a very considerable difficulty of breathing occurs, and the patient complains of a sensation, as if cords were drawn across the chest, and of a peculiar tightness at the scrobiculus cordis. If the part, where the pain and uneasiness were first felt, is now examined, a soft puffy tumour may be noticed, which is so very prominent as to prevent the ribs immediately under it from being felt. This tumour increases very rapidly, and is soon diffused over all the chest; but is particularly conspicuous on the neck, breast, and face. The rapidity, with which it now spreads over the whole surface of the body, is amazing, and, in many places, the skin is elevated several inches from the subjacent bones and muscles. When the swelling has become general, the patient finds it extremely difficult both to expire and inspire; the motion of the extremities is very much impeded, and, indeed, when the skin is considerably elevated, such motion is almost entirely prevented. The integuments crackle under the hand; the skin is much paler than natural, feels cold, and when struck, sounds like a wet drum. The air may, in general, be easily pressed from any part; but it returns to the same place again as soon as the pressure is removed. The respiration is exceedingly laborious, and quick. The patient inspires with a sudden effort, and the air, in passing the epiglottis, makes a peculiar noise. Expiration follows inspiration almost instantaneously, and is performed with a deep sigh, or rather groan. The patient is incapable of lying with comfort on either side of his body, and feels most ease, and breathes best, when sitting half erect in bed. The skin and extremities feel very cold. The pulse is sometimes quick and hard; at other times, it is hard and full; but it can only be felt with some difficulty. The eye-lids are frequently so puffed up that the patient cannot see; the features are very much deformed; and the lips assume a purple, or rather a livid hue. At the beginning of the case there is generally

a short tickling cough, which increases with the other symptoms, so as to become almost incessant. What the patient spits up is generally very frothy and mixed with blood. The tongue is dry, and the patient complains of a constant thirst. The voice becomes very weak, and unless the effused air is speedily let out, so as to reduce the swelling and pressure, the patient dies suffocated. (See observations on Emphysema, 1807.) It is utterly impossible for any one to understand the subject of emphysema, without previously having some idea of the manner in which the function of respiration is naturally carried on. He must at least know, that, in the perfect state, the surface of the lungs always lies in close contact with the membrane lining the ribs, both in inspiration and expiration. The lungs themselves are only passive organs, and are quite incapable, by any action of their own, of expanding and contracting, so as to maintain their external surface constantly in contact with the inside of the thorax, which is continually undergoing an alternate change of dimensions. Every muscle that has any concern in producing an enlargement, or diminution, of the chest, must contribute to the effect of adapting the volume of the lungs to the size of the cavity in which those organs are contained. This must happen while there is no communication between the cavity of the pleura and the external air, and while there is no breach of continuity in the surface of the lungs themselves. In the act of inspiration, the thorax becomes enlarged in every direction, the lungs are proportionally expanded, and the air entering through the windpipe, into the air-cells of these organs, prevents the occurrence of a vacuum. On the other hand, in the act of expiration, certain muscles diminish the capacity of the thorax, and the lungs being of course compressed, a large portion of the air, which had just before been inhaled in the preceding inspiration, is again expelled from the trachea.

The few observations, already made, must render it obvious to every reader, that by the constant continuance of the surface of the lungs in close contact with the inside of the chest, both in its enlarged and diminished state, the air is regularly drawn into, and expelled out of the air-cells of those important viscera. It must also be manifest, that immediately a free and direct opening is made through the skin and muscles into the cavity of the chest, some air must enter through the wound, and insinuate itself into this last situation, on the dimensions of the thorax being enlarged by the action of the muscles of inspiration. The lungs on the wounded side, of course, remain collapsed, and less air is drawn into the trachea, in proportion as a larger quantity accumulates between the inside of the chest and the outside of the lungs. In this manner, the expansion of these latter organs on one side becomes gradually more and more obstructed. A certain part of the accumulated air, it is true, is forced out of the wound again in each expiration; but a larger quantity enters at every inspiration, and the lungs on the injured side become at last quite collapsed.

Cases of this kind, by which we imply wounds, attended with a free and direct opening into the cavity of the chest, can never be attended with any serious degree of emphysema. If the wound be not quite ample and straight, a certain quantity of air, expelled at each expiration, instead of getting out of the external orifice, may undoubtedly insinuate itself into the adjoining cellular substance, and occasion some emphysematous swelling. However, this never spreads, under such circumstances, to any considerable extent.

The emphysema also, abstractedly considered, is never productive of much danger, when there is a free and direct opening into the chest; for it will be presently understood

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that the danger, in emphysematous cases, depends on the manner in which the air is confined in the cavity of the chest, so as to produce such a degree of pressure on the mediastinum and diaphragm, as obstructs the function of the opposite lung, and occasions a fatal suffocation. Now the very existence of a free opening removes the possibility of the air accumulating in such a manner in the chest, as to cause any dangerous degree of pressure on the diaphragm and other lung. This latter supports life, while the lung on the wounded side lies quietly collapsed, till the wound in the parietes of the chest has healed, and the air has been absorbed.

The foregoing remarks must make us perceive what wisdom there is in the arrangement, of having the chest divided into two cavities, which have no communication with each other. If things were not so ordained, suffocation would be a common consequence of every large wound, that extended into the chest. Bertrandi informs us, that whenever a free opening is made into each side of an animal's thorax, the lungs collapse, and suffocation is always the consequence.

However, wounds which merely penetrate the chest, without wounding the lungs, are never attended with any considerable degree of emphysema. Whatever emphysematous swelling does arise is also produced by the external air, which passes into the thorax through the wound, in the act of inspiration, and out of the orifice of the injury again, when the patient diminishes the capacity of the chest in expiration.

The cases of emphysema, most apt to be attended with alarming symptoms, interrupted respiration, and an extensive diffusion of air in the cellular substance of the body, are commonly produced by narrow oblique stabs, which penetrate the parietes of the chest, the pleura costalis, and pleura pulmonalis, so as to make an opening into the air-cells of the lungs. Emphysema also frequently assumes the same urgent and dangerous form, in cases of fractured ribs, the sharp spiculae of which, being driven inward, tear the pleura costalis, pleura pulmonalis, and surface of the lungs themselves. The latter instances differ from wounds in the circumstance of there being no breach of continuity in the integuments. We have already explained, that whatever air insinuates itself into the cellular substance, in wounds, which simply enter the chest without injuring the lungs, must be derived from without; that is, it first passes into the thorax through the wound. But when emphysema arises from narrow oblique stabs, which enter the chest and injure the lungs; or when the affection originates from the pleura costalis, pleura pulmonalis, and part of the substance of the lungs being torn by the sharp points of a broken rib; whatever air becomes diffused in the cellular substance, first escapes from the breach in the air-cells of the lungs into the cavity of the thorax, and thence is expelled through the wound, or laceration in the pleura costalis, into the common cellular substance, situated on the outside of this latter membrane. In wounds, which simply enter the thorax, without injuring the lungs, the air passes through the opening, into the cavity of the pleura in inspiration, at the same time, and from the same causes, that the air also enters the lungs through the trachea. Circumstances, however, are exceedingly different, when emphysema arises from narrow oblique stabs, or fractures of the ribs, attended with an injury of the lungs. In the first of these cases the air cannot enter the cavity of the chest in the same manner as it does when there is a free and direct opening made in the parietes of the thorax. In the second instance, (namely, fractured ribs,) there is no external orifice at all. Both

these latter kinds of cases, being also accompanied by a wound of the lungs, are essentially different, in many respects, from such examples of emphysema as proceed from a wound, which only enters the chest without doing any mischief to the lungs. When the surface of these organs is wounded, no sooner does the chest become expanded in the act of inspiration, than some of the air escapes from the breach in the substance of the lungs, gets into the cavity of the pleura, and afterwards insinuates itself, through the opening in the pleura costalis, into the common cellular substance.

We shall next endeavour to make the reader understand more clearly the cause of the air collecting in the chest, and becoming effused in such cases of emphysema as proceed from wounds, or injuries, which cause a breach either in the pleura pulmonalis alone, the pleura pulmonalis and pleura costalis together, or in the integuments, muscles, and pleura costalis, without the pleura pulmonalis being at all concerned. We shall enter into this part of the subject rather fully, because it is by no means well understood by the generality of surgeons, and, without a clear comprehension of it, the practitioner must feel completely in the dark, in regard to the right mode of treating the affection.

Dr. Halliday notices, that the lungs in the thorax have often, and not unaptly, been compared to a bladder in a close pair of bellows; but, if we suppose the bellows to be divided into two compartments, and each of these to contain a bladder, which mutually communicate with each other, and with the external air by means of a tube, which is exactly adapted to the nozzle of the bellows, and which admits the air only into the cavity of the bladders, and not into the space betwixt the bladders and bellows, we shall then have a perfect representation of the mechanical structure of the thorax. The bellows will represent the thorax, divided in the middle by the mediastinum; the bladders will represent the lungs of the right and left sides; and the tube, which communicates with the bladders and the external air, will represent the trachea. The only thing which is wanting to render this mechanical representation perfect is, that the bladders should exactly fill the bellows, so as to leave no air betwixt them and the bellows.

It is evident, says Dr. Halliday, that when we lift up the handle of the bellows, the bladders will be filled by the external air rushing in through the tube, which communicates with both, and that, when we depress the handle, the air will be again expelled. Dr. Halliday conceives that this is exactly the way in which the lungs are filled and emptied in respiration. The cavity of the thorax being enlarged, by the contraction of the diaphragm and intercostal muscles, &c. a vacuum is formed, into which the air rushes through the trachea, and we perform what is called *inspiration*; whereas, by the contraction of the abdominal muscles, and relaxation of others, the cavity of the thorax is diminished, and the air is expelled, or we *expire*.

The bellows and bladders, continues Dr. Halliday, will also serve to illustrate the cases of injury mentioned as giving rise to emphysema, and first as occasioned by the pleura pulmonalis of one side being wounded, or ulcerated. This case is, in many respects, the same as if an opening were made in one of the bladders, and which opening would form a communication with the space betwixt the bellows and bladder on one side. Now, suppose that this takes place while the handle of the bellows is depressed, as soon as the handle is raised, air will rush into the space betwixt the bladder and bellows, and, if you keep the handle up for a little time, the bladder will collapse altogether, and the place which it naturally occupied, when distended, will

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now be occupied by the air. If we attempt to force out the air by depressing the handle of the bellows, we shall find that this cannot be done; for there is no direct communication betwixt the bellows and external air; and, as the effused air presses equally on all parts of the collapsed bladder, it cannot escape through it. Dr. Halliday next explains, that by the action of the muscles of inspiration, the pressure is removed from the surface of the wounded lung, and the air, which should have rushed in and distended the lung, now passes through the wound, into the space betwixt the pleura pulmonalis and pleura costalis. In the living body the whole of the air inspired will not be thus effused; but, as it must pass through the lung, it will also at first distend it, more or less, according to the size of the opening in the pleura pulmonalis, and this partial dilatation of the wounded lung will always happen while air continues to be inspired on that side. As soon as expiration begins, the general cavity of the thorax being thereby diminished, the effused air will be compressed against the wounded lung; but none of the air which has escaped can re-enter the lung again, because the whole of the air contained in the lung must be forced out, and the pressure against every part of the collapsed lung being equal, will prevent the effused air from separating any part, so as to make a passage for itself into the trachea. In this manner fresh air is accumulated in the space betwixt the pleura at every inspiration, while none is allowed to escape during expiration, and the quantity accumulated at last will be equal to that which was received into the other lung, during the most powerful inspiration after the accident. Dr. Halliday next notices, that this kind of accumulation of air in the chest has been denominated *thoracic emphysema*, and has been supposed to have sometimes proved fatal, without any more extensive diffusion of the air.

Dr. Halliday afterwards informs us, that when an opening exists both in the pleura pulmonalis and pleura costalis, the same circumstances happen as in the foregoing case, till the lung has collapsed; but, that if the patient now attempt to expire, the injured side of the thorax must continue distended, notwithstanding every effort. However, in general the air makes a way for itself through the cellular membrane, and as the passage of air into the cavity of the thorax, during inspiration, is easier than the return of that which has been already effused into the cellular membrane, this effusion continues to go on with great rapidity, while the patient lives, so as to occasion what has been termed *subcutaneous emphysema*.

The above writer also observes, that in the case of a wound which simply penetrates the chest, without hurting the lungs, if the access of air be more free by the wound than by the trachea, more air will enter during inspiration into the cavity of the thorax than into the lungs; and that if the access of air be, on the contrary, less free, then also less air will enter the thorax than the lungs. However, Dr. Halliday remarks, that in the same proportion as air enters into the lungs, or into the cavity of the thorax, it will likewise be expelled from these cavities during expiration. Hence, air would not accumulate in the thorax, did not the lungs always tend to collapse from their natural gravitation. Perhaps no author has offered a more accurate and spirited description of an emphysema arising from a fractured rib than Mr. John Bell, of Edinburgh. This gentleman remarks, that when a rib is broken, the point of the broken bone is pressed down upon the surface of the lungs, so as to lacerate them. It is often from the slightest and most superficial wound of this kind, that the emphysematous tumour proceeds, the laceration of the lungs ex-

tending to so inconsiderable a depth in the lungs, that it does not even occasion the least spitting of blood, or any other symptom of a deep wound; and Mr. John Bell observes, that if the patient die, the wound cannot be seen even after dissection; but can only be discovered by inflating the lungs. Yet, says this gentleman, the surface of the lungs being touched even in this slight way, the air escapes from them at every inspiration; the air which is then within the cavity of the thorax is of course compressed, so that at the next expiration this compression must force the air either back again into the lungs, or else out of the wound in the parietes of the thorax, and thence among the cellular substance surrounding the broken rib. Thus, observes Mr. John Bell, in every inspiration there is a suction of some air, which is drawn through the wounded lungs, the air expands in the cavity of the thorax, the lung which gave out that air subsides again, and lies almost entirely quiescent, partly from the wound in it, which, like a rent in a bladder, prevents it from being inflated, and partly from the pressure of the air in the cavity, in which there ought to be a vacuum to make the lung expand. Every new inspiration draws more air from the wounded lung, and every new expiration drives more air out into the cellular substance. There is no further outlet for the air, which makes its way forwards, and (to use Mr. John Bell's expression) undermines the common skin with wonderful rapidity. Thus, the emphysematous crackling tumour appears first over the broken rib, or over the wounded point of the thorax; then extends over the whole chest, attended with great oppression of the breathing; then over the neck and face, and filling the eye-lids particularly, so that the eyes are absolutely closed. Next it spreads over the belly, and down the thighs. At last, the private parts become enormously swollen, and no part escapes this tumour, except the palms of the hands and soles of the feet. More air, says Mr. John Bell, is every moment drawn out from the wound of the lungs, and driven under the skin; the patient is every moment more and more oppressed; till, at last, the breathing is quite interrupted, the pulse flags, the extremities grow cold, and the patient, if he be not relieved by some operation, must die.

According to the same writer, the wounded lungs collapse, and continue in this state until the breach in them has healed, which happens in a very few days. From the moment when the lungs are wounded, the use of the wounded lobe is lost, so that if the right lung be the one injured, the breathing is entirely carried on by the left, only half the quantity of air is inspired, and the respiration is attended with difficulty. Mr. John Bell considers this collapse of the injured lung, which must inevitably continue for at least a few days, a chief means of safety, at the same time that it is a cause of distress. He observes, that when the lungs are unfolded their vessels have their full diameter, they hold their full proportion of blood, and, if they were not collapsed, their wounded vessels would be in a condition to emit a considerable quantity of blood. But, the fact is, when one of these organs is wounded, it collapses towards the spine, and can no more be filled than a torn bladder can be inflated. The lung is also oppressed by whatever air or blood may be effused in the cavity of the thorax. The collapse of the lung causes less blood to be extravasated in the chest, and less to be thrown into the bronchiz, which latter kind of hemorrhage is even more dangerous than that which takes place in the cavity of the pleura, because it may not only affect the wounded lung, but obstruct the entrance of air into the other one, so as to produce a fatal suffocation.

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Mr. John Bell very judiciously remarks, that, if the injured lung were not to collapse, it would be difficult to conceive, how the breach could ever be healed; for, the air would be continually streaming through the wound, which becoming alternately dilated and contracted, like that of an artery, could never close. However, since the wounded lung lies in a collapsed state, the edges of the wound are in contact with each other. We find by dissection, that a slight effusion of blood, a degree of livor, a swelling, thickening, and inflammation, take place round the wound, and thus, in two days, the breach is closed. The lung becomes again entire, and capable of resuming its functions.

Mr. John Bell also takes notice, that the blast of air, from a wound in the thorax, is often so strong, that at every breath it is capable of extinguishing a candle, and rushes out with a considerable noise. This stream of air, so far from being a sign of wounded lungs, is often most remarkable, when the lungs are absolutely entire. It is a sign of a free and open wound in the chest; but, by no means of wounded lungs; for whether these organs be wounded or not, the air enters so freely by the outward wound, when ample and direct, that there is no vacuum formed to give the lung play, and it must collapse, till the external wound has healed. Wounds of the thorax, therefore, are totally different cases from wounds of the lungs. When the chest has a large free opening made into it, it is (as Mr. John Bell describes) like a pair of bellows, having a large air-hole, which admits the air every time the breast rises; and expels it again as often as the breast falls down. The air is alternately drawn in, and thrown out at every respiration, with a strong blast; but, whatever air issues through the wound, had been drawn in by the wound, and had never passed through the lungs. Hence, when there is a free opening made in the thorax, no vacuum can form so as to lead to the expansion of the lung, and whether entire, or injured, it must be in a collapsed state.

We may be convinced, that the lung, on the side opposite the wound, is adequate to the temporary support of life, by the recollection of several kinds of cases. When a large free opening has been made into the chest by some accident, or by the surgeon's knife, the lungs on the injured side of course collapse; yet, the patient has often been known to live with tolerable ease in this condition, until a perfect recovery has followed. When the right or left lung has been utterly prevented from becoming expanded, in consequence of the pressure of air in emphysema, water in hydroys pectoris, or pus in empyema, the patient has often lived a considerable while in this state, and ultimately got well. Persons have lived so long with disease in the chest, that when they have died, and their bodies have been opened, only a small knob, or tubercle of the lungs on one side, has been found remaining. See Koelpen de Empyemate Observatio, p. 135, 136.

When the lungs are wounded by the point of a broken rib, or when they are injured by a narrow stab in the thorax, the air cannot readily escape from the cavity of the chest, while at every inspiration more and more is drawn out from the lungs, till at last such a quantity accumulates, that it not only oppresses the lung, which is on that side, but by hindering the free action of the diaphragm, and loading the mediastinum, it oppresses the other lung also. In this manner, the breathing becomes gradually more and more interrupted; the pulse sinks; the extremities grow cold; and after great tossing, and undescribable anxieties, the patient dies. All this may happen, even when a part of the air escapes through the breach in the pleura costalis, so as to inflate a

great part of the common cellular membrane of the body. See Discourses on the Nature and Cure of Wounds by John Bell, vol. ii.

From what has been stated, it must be evident, that the emphysematous swelling itself, or, in other words, the diffusion of air in the cellular substance, is a matter of secondary consequence, and, that the great peril of an emphysema depends on the manner in which one side of the chest may become so distended with air, that the pressure produced on the diaphragm, mediastinum, and opposite lung, occasions a fatal interruption of respiration.

However, in cases in which there is a free and open wound in the parietes of the chest, or when the surgeon has made an ample and direct incision into the thorax, the opening, in fact, does not relieve the lung on the same side, but the opposite one, by obviating the pressure of any confined air on it. In the mean while, the lung on the wounded side lies in a collapsed state, till the wound in it has healed.

It is curious to observe, how few of our best modern surgical writers have had accurate notions concerning emphysema. Hewson, Benjamin Bell, and Bromfield, have all fallen into the mistake of supposing it possible to make the wounded and collapsed lung immediately expand again by exhausting the air from the cavity of the pleura. Mr. Bromfield writes, "in case an opening is made between the ribs, and a cannula introduced, whose diameter is larger than the wound of the lungs, the air will be forced out as fast as it escapes from the lungs, therefore the lungs will have room for their expansion," &c. See *Chirurgical Cases and Observations*.

Mr. Hewson observes, "it is natural to suppose, that the wound of the pleura and intercostals may sometimes be too small to suffer the air to get readily out into the cellular membrane, and to inflate it, but may confine a part of it in the cavity of the thorax, so as to compress the lungs, prevent their expansion, and cause the same symptoms of tightness of the chest, quick-breathing, and sense of suffocation, which water does." Mr. Hewson seems to have no idea of the danger of suffocation proceeding from the pressure on the opposite lung, and though he wrote professedly to recommend paracentesis thoracis in these cases, he advises making a small incision, rather than a large one, *lest the air should enter, and hinder the expansion of the lungs*. *Med. Obs. and Inq.* vol. iii.

Mr. Benjamin Bell has undoubtedly run into most strange absurdities in the description in his *System of Surgery*, of plans for expelling the air from the surface of the lungs. "While the wound yet remains open," says he, "let the patient, in a slow gradual manner, make a full inspiration, by which a considerable quantity of the collected air will be discharged. This being done, the skin must be instantly drawn over the *fore*, so as to cover it completely during inspiration; and if the wound be moderately opened during inspiration, the whole quantity will be soon expelled."

In this passage, the author has obviously confounded the words expiration and inspiration, besides displaying ignorance in thinking it practicable to make the collapsed wounded lung rise up again by such proceedings.

The same author remarks: "the other means which we wish to propose for drawing off air from the thorax, is suction; an exhausting syringe may be fitted with such a mouth of ivory or metal, as will allow it to be closely applied over the orifice in the pleura:" He adds, that "as much distress has, on some occasions, ensued from both cavities of the chest being at the same time laid open, it ought never to be attempted." He afterwards imputes the danger, not to the collapse of both the lungs, but to the inflammation likely

## EMPHYSEMA.

likely to arise from the admission of air into the two cavities of the chest at once. The fact is, a free opening made into each side of the chest at the same time would be instantly followed by a collapse of both lungs, and immediate suffocation. There would neither be time for any inflammation to arise, nor for relieving the patient with exhausting syringes.

There is certainly a possibility of making the lungs expand again, by syringes, &c. as soon as the breach in them has healed, or the injured air-cells have been closed with coagulating lymph; but, the propriety and utility of the plan may be justly called in question. The introduction of pipes into the chest cannot be done without irritation; no more air can escape from the lung now the air-cells are closed; what is already effused in the chest will be absorbed, and the lung expand again, in proportion as this is effected; and should the diaphragm and opposite lung suffer dangerous pressure from the large quantity of accumulated air, relief may be derived from making an opening in the distended side of the chest, sufficient for letting out a certain quantity of the confined air. In this instance, a small puncture in the pleura would suffice: the case is not like some others, in which the breach in the lung is not closed, and a very free and direct opening is required, in order to let the air escape from the thorax, as fast as it passes out of the wound in the lung itself. By this step, and no other, can we prevent the spreading of the emphysematous swelling over the whole body, and what is of still higher moment, a perilous degree of pressure on the diaphragm and opposite lung.

Some of the most remarkable cases of emphysema, on record, are related by M. Littré, M. Mery, Dr. Hunter, and Mr. Cheston, in the *Mem. de l'Acad. Royale des Sciences* for 1713, *Medical Observations and Enquiries*, vol. ii, and *Pathological Enquiries*.

With respect to the treatment of emphysema, when the air becomes effused in the cellular substance round a wound, which merely injures the parietes of the chest, the best plan must be to direct the patient to expel as much of the air from the thorax as he can, by making long expirations, the opening being regularly closed when the patient enlarges his chest in inspiration. After getting as much air as possible out of the thorax in this manner, the edges of the external wound may be carefully brought together, and well covered with adhesive plaster, compresses, &c. so as to prevent the ingress of any more air into the chest. The emphysematous swelling can now no longer increase, or, at all events, can only do so as long as whatever air is still in the chest continues unexhausted; and in proportion as it becomes effused, or is absorbed, the lung must expand and resume its function again. In this particular instance, as there is no breach in the lung, the practitioner, if he thinks proper, may endeavour to make the viscus expand again at once, by drawing the air out of the cavity of the pleura with a syringe. However, since all examples of emphysema, which are attended with urgent symptoms of suffocation, are accompanied by a wound or laceration of the air-cells of the lung, we cannot rationally attempt to make this organ immediately expand again by means of suction. The thing is not practicable, because how can we exhaust the air from the chest, as long as more is capable of passing out of the opening in the lung itself. We have likewise already explained, that the collapsed state of the injured lung is the most favourable for the closure of the wound in it, and for the prevention of hemorrhage from its vessels.

In all considerable cases of emphysema, the air, effused in the cavity of the thorax, and common cellular membrane, is derived from a rent, or wound in the substance of the

lungs. The worst symptoms in these instances, as we have already repeatedly insisted upon, depend on the pressure of the air confined in the injured side of the thorax, on the diaphragm, and opposite lung. Both this accumulation of air, and the diffusion of another portion of it in the cellular texture of the body, are entirely owing to one circumstance, *viz.* there being no free and direct passage through which the air can escape outward, as fast as it passes out of the breach in the lung.

The inflation of the external parts with air, a thing which often takes place in an enormous degree, is not itself a case of urgent danger, and, indeed, it is so far a favourable event, as it proves, that the air effused from the lung can escape from the cavity of the pleura in a certain measure. If it could do so with sufficient celerity, no oppression of the diaphragm and opposite lung would be occasioned.

In cases of emphysema, Mr. John Bell recommended the following treatment to be adopted. 1st. Upon observing the crackling tumour begin to form over a fractured rib, small punctures should be made with the point of a lancet, and, if the instrument be carried deeply enough, the air will rush out in an audible manner. As this air was in the thorax before it came into the cellular substance, it is plain, that the thorax is still full, and that the lung of that side is already collapsed and useless, and must continue so for a certain time; that is until the breach in it is closed. The purpose, therefore, of making these scarifications, and especially of making them so near the fractured part, is not to relieve the lungs, but merely to keep the air from spreading more widely beneath the skin.

When the emphysema proceeds from a narrow stab in the chest, the practice should of course be the same, in the same stage of the case, or, in other words, at the period when the external emphysematous swelling is in an incipient state. The two examples resemble each other, inasmuch as the lungs and pleura costalis are wounded in both cases, and the air, which passes through the breach in the pleura, cannot make its way completely outward; but becomes diffused in the cellular membrane.

2dly. If, before the surgeon arrives, the air should have spread to very remote parts of the body, as to the scrotum and down the thighs, it will be easier, says Mr. John Bell, to make small punctures in those parts, in order to let out the air directly, than to press it along the whole body, till it arrives at the punctures, made on the chest, over the wounded part.

3dly. If, notwithstanding free punctures, and pressing out the air in this way, it should be found by the oppression, that either air or blood is accumulating within the cavity of the thorax, so as to oppress not the wounded lung only, which, from the first, is of course collapsed and useless, but, also, so as to oppress the diaphragm and other lung; then a freer incision must be made through the skin and muscles, and a small one in the pleura costalis, in order to let the confined air out of the thorax.

In the course of a few days the wound in the collapsed lung becomes closed by the adhesive inflammation, in which process the breach in the air-cells is shut up with coagulating lymph, and the air can no longer get out of them into the cavity of the chest. The air, which is already there, is alternately absorbed, and the lung, expanding in proportion, resumes its original functions.

Emphysema has been known to arise from the bursting of a vomica, and ulceration of the surface of the lungs; but the air, which escapes in this instance, cannot find its way into the cavity of the thorax, because the inflammation, which precedes the abscess and ulceration of the air-cells,

closes those which are adjacent, and produces an adhesion of the edges of the vomica, or ulcer, to the inner surface of the chest, so as entirely to separate the cavity of the abscess from that of the thorax. We do not know of any example, in which the symptoms imputed to the confinement of air in the chest, originated in consequence of suppuration and ulceration of the surface of the lungs. However, Palfyn, Dr. Hunter, and the author of the article "Emphysema" in the French Encyclopædia, have seen cases, in which emphysema has arisen from abscesses of the lungs, attended with adhesion to the pleura, and ulcerations in the situation of such adhesion. In these cases, the pus having made its way through the pleura, and intercostal muscles, the air escapes also through the same tract, so as to get into the cellular membrane on the outside of the chest.

A certain degree of emphysema has been observed to be occasionally produced by a violent effort of respiration. In the instances referred to, the air is said first to make its appearance about the clavicles, and afterwards to spread over the neck and adjacent parts. The violent efforts of parturition have also been remarked to occasion a similar symptom; but without being followed by any bad consequences. See Medical Communications, p. 176.

In the fourth volume of the Mémoires de l'Académie de Chirurgie, 4to. M. Louis has described an emphysema of this latter sort, which, on account of its cause, and the indication which it affords the practitioner, is highly important. M. Louis had occasion to remark the occurrence in a young girl, who died suffocated, from a bean falling into her wind-pipe, and he considers the kind of emphysema in question as a pathognomonic symptom of such an accident. If this opinion be correct, a knowledge of the circumstance must be of great importance to the practical surgeon; for, if making an opening into the trachea, and attempting to extract the foreign body be delayed, from any doubt concerning the nature of the case, the patient will inevitably die of suffocation. In the case which first attracted the attention of M. Louis to the subject, the emphysema made its appearance on both sides of the neck above the clavicles, and came on suddenly, on the third day after the foreign substance had fallen into the trachea. On examining the body, after death, the lungs and mediastinum were also found to be in an emphysematous state. The retention of air by the extraneous substance produced, according to M. Louis, at every attempt to expire, and, particularly, during the violent fits of coughing, a strong propulsion of this fluid towards the surface of the lungs into the spongy substance of these viscera. The air next insinuated itself into the cellular texture, which unites the surface of the lung to the pleura pulmonalis; and, by communications from cells to cells, it occasioned a prodigious swelling of the cellular substance, between the two layers of the mediastinum. The emphysema increasing, at length made its appearance above the clavicles. This tumefaction of the lungs and surrounding parts, in consequence of air getting into their spongy and cellular texture, is an evident cause of suffocation, and M. Louis observes, that the swelling seems to be so natural an effect of the presence of a foreign body in the trachea, that one can hardly fail to think it an essential symptom, though no author has made mention of it.

An emphysema of the head, neck, and chest, has also been noticed in some typhoid fevers. Dr. Huxham relates an instance of this sort, which took place in a sailor of a scorbutic habit. Medical Observations and Inquiries, vol. iii. art. 4.

Surgical practitioners have frequent occasion to remark the occurrence of a partial emphysema in cases of gangrene.

Emphysema, arising from wounds in the thorax, is very often a case, complicated with large extravasations of blood in the chest, and inflammation of the pleura and lungs; circumstances which must greatly increase the danger, and ought materially to influence the mode of treatment.

The adhesions, so frequently met with between the pleura costalis and pleura pulmonalis, must obviously have the effect of preventing the collapse of the lung, in circumstances under which it would otherwise happen. Were a wound to enter through the middle of any adherent parts, it is plain that no air could find its way out of the lung into the cavity of the thorax.

EMPHYTEUSIS, in the *Civil and Canon Law*, the letting out of poor barren lands for ever, or at least for a long term of years, on condition of the tenants cultivating, meliorating, or mending them, and paying a certain yearly consideration.

The word is formed of the Greek, *εμφυτευσις*, which signifies an *engraftment*, and by metaphor, a *melioration* or *amendment*; for as we only graft trees to mend them, so a man only alienates his land by emphyteusis, on condition of having it amended.

Emphyteuses are a kind of alienations, differing from sales, in that they only transfer the *dominium utile*, the benefits of the ground, not the property, or fee-simple. Among the Romans they were at first temporary, afterwards perpetual.

The twentieth canon of the council of Carthage prohibits the bishops seizing the church's emphyteusis out of the hands of private persons, unless they have been three years without paying rent.

EMPIRE, the territory or extent of land under the command and jurisdiction of an emperor. See EMPEROR.

We say the Roman empire, the empire of the East, the empire of the West, or the western empire, the empire of the Great Mogul, &c.

Antiquaries distinguish between the medals of the *upper* and *lower*, or *bas empire*: the curious only value those of the upper empire, which commences with Cæsar or Augustus, and ends in the year of Christ 270.

The lower empire comprehends nearly 1200 years, reckoning as low as the destruction of Constantinople, in 1453.

They usually distinguish two ages, or periods of the lower empire; the first beginning where the upper ends, *viz.* with Aurelian, and ending with Anastasius, including about 200 years; the second beginning with Anastasius, and ending with the Palæologi, which includes about 1000 years. See MEDAL.

In ancient history we read of four great monarchies or empires, *viz.* that of the Babylonians, Chaldeans, and Assyrians; that of the Medes and Persians; that of the Greeks; and that of the Romans. The first subsisted from the time of Nimrod, the same with Belus, or, as others say, from the time of Ninus, the son of Belus, who founded it in the year B.C. 2059, according to Blair's tables, to Sardanapalus their last king, B.C. 820, and consequently lasted about 1239 years. But chronologists differ much concerning both the commencement and duration of the Assyrian empire. (See ASSYRIA.) The empire of the Medes commenced under Arbaces in the year B.C. 821, and was united to that of the Babylonians and Persians under Cyrus, in the year B.C. 538, and it closed in the 5th year of Darius Codomannus, who was conquered by Alexander B.C. 331. The dominion of Persia, after the death of Darius, was transferred to the Greeks. The Grecian empire lasted only during the reign of Alexander the Great, beginning in the year B.C. 336, and terminating with the death of this conqueror B.C. 323, his conquests being divided

vided among his captains. The Roman empire commenced with Julius Cæsar, when he was made perpetual dictator, after the battle of Pharsalia, in the year of the city 706, 48 years B.C. Some, however, date the commencement of the Roman empire after the battle of Actium, with the first year of Augustus, A.U.C. 723, B.C. 31. The decline of the Roman empire may be considered as principally owing to the despotism of Severus, and the passive obedience of the people. From this period we behold a train of emperors vicious, or impotent, either wilfully guilty, or unable to assert the dignity of their station. The empire itself gradually decayed, harrassed on all sides by powerful invaders, and convulsed by the furious contests of domestic foes. During the reign of Gallienus, 30 pretenders contended for the supreme power, and added all the calamities of civil war to the misfortunes of this devoted empire. The power and influence of the emperors were likewise diminished by the adoption of several colleagues, and by the division of the empire between the two sons of Theodosius the Great, A.D. 295. Arcadius was proclaimed emperor of the East, and Honorius emperor of the West. The western empire contained all Italy, Spain, France, Britain, Germany, Pannonia, and Africa. The eastern empire comprehended Asia the Less, Arabia, Syria, Egypt, Lybia, and the several regions on the Danube. The seat of the empire was removed to Byzantium by Constantine, in the year of our Lord 328: the East and West were then united under the title of the Roman empire, till the Romans proclaimed Charlemagne emperor, A.D. 800. From this epocha the East and West formed two separate empires; that of the East, governed by Greek emperors, commenced under Nicephorus, A.D. 802, or, rather, was continued; but being gradually weakened, terminated under Constantine Palæologus, in 1453, when the Saracens, having subdued Syria, Palestine, Egypt, Cilicia, and other neighbouring countries, and having ravaged the rest of the Roman territories in the East, besieged Constantinople under Mahomet II. and became masters of it. From this period the city has been the imperial seat of the Turkish or Ottoman emperors. The western empire, properly so called, terminated with Augustulus, son of Nepos, A.D. 476, but being revived under Charlemagne, it ended with Charles Le Gros, who possessed all the dominions of Charlemagne, A.D. 887, and it was afterwards known by the appellation of the *empire* or German empire.

EMPIRE, or the EMPIRE, used absolutely, and without any addition, long signified the empire of Germany, called also in juridical acts and laws, the *holy Roman empire*, S. R. I. q. d. *sacrum imperium Romanum*, which constituted what was otherwise called the *Germanic body*.

The empire had its beginning with the ninth century; Charlemagne being created first emperor by pope Leo III. who put the crown on his head in St. Peter's church on Christmas day, in the year 800.

Authors are at a loss under what form of government to range the empire; some suppose it to have been a monarchical state, because all the members thereof are obliged to ask the investiture of their states of the emperor, and to take an oath of fidelity to him.

Others maintain that it was a republic, or aristocratic state, because the emperor could not resolve or determine any thing without the concurring suffrages of the princes. It is added, that if they required investiture from, and swore fealty to him, it was only as head of the republic, and in the name of the republic, and not in his own; just as at Venice, every thing is transacted in the name of the doge. See DOGE.

Lastly, others will have the empire to have been a mo-

nacho-aristocratic state, *i. e.* a mixture of monarchy and aristocracy; because, though the emperor in many cases seemed to act sovereignly, yet his decrees and resolves had no force, in case the state refused to confirm them.

In fine, we should rather choose to call it an aristo-democratic state, because the diet, wherein the sovereignty is lodged, was composed of princes, and the deputies of the cities, and was divided into three orders, or bodies, called *colleges*, *viz.* the college of electors, the college of princes, and the college of cities.

We say, diet of the empire, circles of the empire, fiefs of the empire, princes of the empire, estates of the empire, members of the empire, capitulations of the empire, recessus of the empire, &c. See COLLEGE, DIET, CIRCLE, PRINCE, CAPITULATION, and RECESSUS.

The states or estates of the empire were of two kinds, *mediate* and *immediate*. The *immediate* states were those who held immediately of the empire, whereof, again, there were two kinds; the first, such as had seats and voices in the imperial diet; the second, such as had none. The *mediate* states were those who held of the *immediate*.

The states which afterwards composed the empire were the princes of the empire, the counts of the empire, the free barons of the empire, the prelates of the empire, the princesses or abbesses of the empire, the nobles of the empire, and the imperial cities. For an account of the subsequent changes which this empire has undergone, see ELECTORS, EMPEROR, and GERMANY.

EMPIRIC, in *Medical History*, from the Greek word *ἐμπειρία*, *experience*, an appellation assumed by a sect of physicians, who contended that all hypothetical reasoning respecting the operations of the animal economy was useless, and that observation and *experience* alone were the foundation of the art of medicine.

The origin of this sect is variously stated by different writers of antiquity, who have attributed it to three different persons. The empiric physicians themselves seem to have considered ACRON of Agrigentum, who was a contemporary and rival of EMPEDOCLES, (a pupil of Pythagoras,) in the 70th olympiad, as their founder; and Pliny has asserted the same opinion, in his sketch of the history of medicine. (Nat. Hist. lib. xxix. cap. 1.) "Alia factio, ab experimentis se cognominans *Empiricæ*, cæpit in Sicilia, Acrone Agrigentino, Empedoclis physici auctoritate, commendato." This account of the rise of their sect was maintained by the empirics, in order to obtain the advantage over the rational or dogmatic physicians, who could only date their origin from the time of Hippocrates. But it has been justly remarked, that the physicians, who lived between the time of Æsculapius, and the period, when philosophy and reasoning were applied to medicine, were empirics in fact, though not in name, in consequence of the rude and imperfect state of the art, and cannot be regarded as sectaries, since all were at that time equally empirical.

The best historians refer the establishment of this sect to a much later period; namely, to about the 123d olympiad (A. C. 260); but they are not agreed as to the individual, who first promulgated the doctrine of empiricism. Galen and others have ascribed the origin of the sect to Philinus of Cos, who was a disciple of Herophilus, to whom he was said to be indebted for the first hints of his system. Herophilus was doubtless more attentive to the use of drugs than any of his predecessors, and the empirics directed their views particularly to the discovery of medicines: his numerous discoveries in anatomy likewise led him, and still more his disciples, to question the value of the reasoning of their predecessors, in whose statements of fact they found so much

error, particularly in regard to the structure of the human body. Little, however, is known with certainty respecting this Philinus. Galen quotes him, when writing on the subject of the composition of medicines; and he is said to have written on the nature of plants, and to have commented on the writings of Hippocrates.

Celsus, however, asserts, that Serapion was the first who maintained the doctrine, that the application of reasoning and philosophy to the art of medicine was of no avail, and confined the study of it to practice and experience. (*De Medicina, Pref.*) Serapion was born, and practised medicine at Alexandria, and appears to have been contemporary with Philinus, and the disciples of Herophilus. Galen accuses him of having shewn a contempt for Hippocrates and all his predecessors, in his writings, and of praising himself on all occasions. (*Galen. de subfigurat. Empir. Cap. ult.*) Apollonius, Glaucias, Heraclides of Tarentum, and others of no small note ("non mediocres viri") followed in the steps of Serapion, according to Celsus. Heraclides was one of the most famous of the empirics, and appears to have been the first to employ that valuable substance, opium, in the practice of medicine. Many other names are on record, as belonging to this sect, antecedent and posterior to Heraclides: one of the latest was Marcellus, who lived in the time of Theodosius, and appears to have held some office in the court of that emperor, and was probably therefore a Christian. He has left a treatise on medicines, compiled from various writers, and adapted to the cure of all diseases. The art of medicine, indeed, is indebted to the empirical physicians for many important additions to the *Materia Medica*. With respect to the doctrines of the sect, however, and the principles on which they defended themselves against the dogmatics, we have no other accounts, than those which their adversaries have given, in quoting them with a view to their refutation; all their works upon these topics have perished. Celsus and Galen have stated probably the greater part of the leading points of their tenets.

The *empiric* system, as the term imports, was founded altogether upon *experience*: and those, who belonged to this sect have remarked, that there are three modes by which we learn, from experience, to distinguish what is advantageous and what is prejudicial, in regard to our health. The first of these, and the most simple, arises from *accident*. A person, for example, having a violent pain in the head, happens to fall, and divides a vessel in the forehead; and it is observed that, having lost blood, his pain is relieved. Under the same mode, they include the experience which is acquired by observing the spontaneous operations of the constitution, where no remedy has been applied, as in the following case: a person labouring under a fever, finds his disease mitigated, after a hemorrhagy from the nose, a profuse perspiration, or a diarrhœa. The second mode of gaining experience, is, that, in which something is done by *design*, with a view to ascertain what will be the success of it: as, for instance, when a person, having been bitten by a serpent, or other venomous creature, applies to the bite the first herb that he finds; or when a man attempts to alleviate the symptoms of an acute and burning fever, by drinking as copiously as he is able of cold water; or when a person tries a remedy, suggested to him by a dream, as was frequently done in heathenish times. The third mode of experimenting, is that which the empirics termed *imitative*; which is pursued in cases, when, after having remarked the effects resulting from *accident*, or the spontaneous actions of the system, on the one hand, or from *design* on the other, we make an attempt to accomplish a similar result, by imitating that which was done on those occasions.

This last sort of experience, they contend, is that which peculiarly constitutes the art of medicine, when it has been frequently repeated. They call that *observation*, (*τηρησις*) or *autopsia* (*αὐτοψία*), which each individual sees himself; and use the term *history*, or *record*, (*ἱστορία*) for such observation when committed to writing; that is, the *autopsia*, or personal experience, consists of the observations which each person has made, by his attention to the progress of a disease, whether in regard to its symptoms and changes, or to the remedies employed; while the record is a sort of narration or register of all that was observed by those individuals; which register being completed, (*i. e.* including all the diseases, incident to mankind, and the remedies administered for their alleviation,) the art of medicine would be established with a considerable degree of certainty. But as new diseases sometimes occur, in regard to which neither our personal experience, nor the observations of others, can furnish us with any assistance; and we meet with disorders in particular situations, where the means of relief, sanctioned by experience elsewhere, are not within our reach; we must necessarily have recourse to some other expedient in order to alleviate the sufferings of the patient. The empirics were provided against this particular difficulty, in what they termed a *substitution* of similar means, (*transitus ad simile*, as the Latins have translated it.) This was a new experiment, which they instituted, after having compared one disease with another; or one part of the body with another, of similar structure; or, lastly, one remedy, the nature of which was ascertained by experiment, with another which resembled it. "They tried, for example, in *herpetic* eruptions the remedies which had relieved *erysipelas*; in the diseases of the *arms*, they employed the expedients which had been practised in those of the *legs*; and if they could not procure *quinces*, which are an austere fruit, they used *medlars*, which are not so."

*Observation*, then, *record*, and the *substitution* of similar means, were the three fundamental resources of the art of medicine; according to the empirics; and these were denominated by Glaucias, and others, the *tripod of medicine* (*τρίπους τῆς ἰατρικῆς*.)

There is obviously a great deal of good sense and sound philosophy in this doctrine of empiricism. It points out the true mode of investigating the phenomena of nature, by unwearied experiment; the mode which Bacon laboured to inculcate on the dogmatists, and hypothesis-mongers of his age, which Newton successfully pursued, and which has led the philosophers of later times to the development of that fund of natural knowledge in the sciences of electricity, chemistry, mechanical, and every branch of natural philosophy, by which modern inquiry is distinguished. Compared with this species of investigation, how futile are the speculations, misnamed philosophy in the schools, relative to elements, and essences, which had no existence, except in the imagination of the disputants. For it must be observed, that the ancient empirics did not disregard the dictates of reason and reflection; they only deprecated the application of them to circumstances out of the reach of the senses, and beyond the scope of experiment. Those mischievous principles and practices, which their successors or at least those who have subsequently assumed the title, have made the refuge of ignorance and craft, cannot be alleged against them. This is evident, from the clear and explicit statement of their tenets, which Celsus has transmitted to us: in order to understand which, it will be necessary to attend to the tenets of their opponents, the rationalists or dogmatics, as stated by the same elegant writer.

## EMPIRIC.

The dogmatic physicians maintained the necessity of a knowledge of the four following subjects, in order to be able to cure diseases; namely, 1, of the occult and essential causes of disease; 2, of the evident causes; 3, of the natural actions of the constitution, (or physiology;) and, lastly, of the internal parts, or anatomy. 1. By the *occult* causes, they meant the essential principles of the constitution, or of animal life, under its various conditions of health and disease. And they held, that it was impossible to cure disease, if we are ignorant of the circumstances in which it consists; for that different methods of cure must necessarily be requisite, if a redundancy or deficiency of the *four elements* were the essential cause of disease, according to the hypothesis of some philosophers; or if all disease consist in depravations of the fluids, as was the opinion of Herophilus; or, in disordered respiration, as Hippocrates imagined; or in the passage of the blood into those vessels, which naturally convey air, causing inflammation, and that inflammation exciting the commotion observed in fever, according to the supposition of Erasistratus; or in the obstruction of the invisible pores, by the corpuscles, or atoms, as Asclepiades contended. Against this system of reasoning by hypothesis, beyond the bounds of experimental inquiry, the empirics objected upon the most irrefragable principles. "The attempt," say they, "to scrutinize the occult principles of animal life is fruitless; for 'nature is incomprehensible:' we may ascertain *what* she performs; but *how* she performs it, is to us inscrutable. And the very dissensions among the theorists, and the difference of their accounts of those operations, evince the inscrutability of the subject. They cannot all be right; and why should we believe the statement of one, rather than that of another? Why is Hippocrates more entitled to credit than Herophilus, or Herophilus than Asclepiades? It is obvious that we cannot decide in favour of the opinion of any of them, either from their arguments, or their practical authority; for the arguments of each may be sufficiently plausible and consistent with probability; and their practice may have been equally successful. Indeed this very fact, that physicians of the most opposite theoretical opinions have equally succeeded in restoring health to the sick, proves the independence of the art of medicine upon such disquisitions, and that their success is to be ascribed to their principles of cure having been deduced, not from their speculations about occult essential causes, nor even about the natural actions, but from experiment, from what actual practice had taught them. And such is the case in all other arts. The husbandman and the pilot are not qualified for their respective occupations by theory and discussion, but by practice and experiment. Indeed if reasoning could enable a person to cure diseases, the philosophers would necessarily be the best physicians; whereas, we observe that they are gifted with an abundance of words, but possess very little skill in the art of healing."

2. With respect to the *evident* causes, the dogmatists understood, by that term, the obvious exciting causes of diseases, such as heat and cold, fasting and excess in eating, &c., to the operation of which diseases are often observed immediately to succeed. The empirics admit the utility and importance of attending to these causes; but they contend that, however obvious they may be in many instances, the method of cure is nevertheless not apparent from them, as in ophthalmia, or in a wound; but is ascertained only from experience.

3. The *natural actions* of the body, a knowledge of which the dogmatists maintain to be absolutely necessary to the physician, are those operations of the constitution, which the moderns comprehend under the term physiology; namely,

the nature of respiration; of the concoction or digestion of our food and drink, and its distribution to the different parts of the body, which it nourishes; of the "rise and fall" of the arteries; of sleeping and waking, &c. "Without an acquaintance with the causes of these actions," say the rationalists, "it must be impossible for any one either to suppress incipient diseases, or to cure them when they are completely established." But of all these actions, they deem the digestion of the food the most important, and insist more particularly upon the necessity of its being understood. But in this point again there is great dissension among them: some of them, following the hypothesis of Erasistratus, maintain that the food is concocted by mechanical attrition; others, after Philonicus, the disciple of Praxagoras, assert that digestion is produced by the putrefaction of the food; while others prefer the opinion of Hippocrates, and contend that it is effected by heat. The disciples of Asclepiades, again, affirm that all these hypotheses are idle and futile, for that there is no such thing as concoction, but that the alimentary matter, crude as it is received, is distributed through the whole body. Various as these opinions are, however, they do not dispute the necessity of accommodating the food of the sick to the nature of the function; that is, if the concoction be the result of attrition, then such food should be selected as is most easily broken down; if it be effected by putrefaction, then such food is to be chosen as is most readily putrescent; if by heat, such as most effectually cherishes heat: but if there be no such process as that of concoction, then all these kinds of aliment are improper, and such only should be taken as most completely resists all change. In the same manner, they contend, when a difficulty of breathing occurs, or a morbid degree of sleep or watchfulness, that physician will be the most capable of curing them, who is acquainted with the nature of these functions.

Against this doctrine of the dogmatists, it is evident that the arguments of the empirics were equally conclusive, as against their preceding hypotheses, respecting the occult causes. Their statements, that the very difference of the theories of the dogmatists implies their want of foundation, and that the mode in which nature operates being incomprehensible, we must be content with learning what she operates, are obvious refutations of the futility of these, and indeed of all other hypotheses. "It is of no importance," say the empirics, "to inquire in what manner the distribution of the aliment through the body is accomplished; our only useful inquiry is, what sort of aliment is most easily distributed; and whether digestion is performed by heat or putrefaction, or whether it is not a digestion, but a distribution only, is altogether immaterial, provided we know, from experience, what is most easy of digestion, or the contrary. For," they continue, "the art of medicine, even in its infancy, was not deduced from such hypothetical reasoning, but from experiments. Whence it was observed, among those who were sick, and without physicians, that some, prompted by appetite, had immediately taken food at the beginning of their illness; while others, loathing victuals, had fasted altogether; and that the disease in those who had abstained from food had been alleviated. It would be remarked, too, that some took food in the paroxysm of a fever, others a little before it came on, and others again after its remission; and that it would agree the best with those who ate after the removal of the fever. In like manner, it would be seen, that those who took food freely in acute diseases, suffered an aggravation of their symptoms, while the abstemious would not thus suffer. These and similar circumstances, occurring daily, would be noted

by

by diligent observers; and what had been seen to succeed most generally, that they afterwards prescribed to the sick. Such was the origin of the art of medicine, which, in consequence of the recovery of some, and the death of others, taught us to discriminate the useful expedients from those that were pernicious: and when remedies were discovered by such experiments, then men began to reason about their operation; for the art of employing remedies was obviously not the result of reasoning, but explanatory hypotheses were sought for after the remedies were ascertained.

4. The dogmatists contend, in the last place, that as pains and various disorders attack the *internal parts*, no person, in their opinion, can apply proper remedies to them, when diseased, if he is ignorant of their situation and appearance. Hence, they affirm, that it is necessary to dissect the bodies of the dead, and to examine the viscera and intestines: and they extol the method of Herophilus and Erasistratus, who procured criminals out of prison, by royal permission, and, having dissected them alive, contemplated, even while they were breathing, the parts which nature had before concealed; and remarked their position, colour, figure, size, arrangement, softness, hardness, smoothness, and connection, as well as their processes and depressions, or what is inserted into and received by each part. "For," say they, "when any internal pain occurs, the seat of that pain cannot be ascertained by one who is ignorant of the situation of the viscera and intestines; nor can he cure any part diseased, who does not know what the part is. Besides, if the viscera happen to be exposed in consequence of a wound, if the observer be unacquainted with the natural appearance of each part, he cannot discover what is sound, and what injured or corrupted, and therefore is not qualified to cure that part which is diseased. Even external remedies are applied with much more judgment by one who knows the situation, figure, and size of the internal parts. Nor can it be justly deemed cruel (although it is generally so represented) to put a few guilty individuals to torture, with a view to ascertain means of relief for all the innocent among mankind in all succeeding ages.

To these arguments the empirics reply, that "the preceding doctrines of the dogmatists were only idle and frivolous, but in this there is the addition of excessive cruelty: for what can be more cruel than to cut open the abdomen and chest of living men, and thus to render that benign art, which is the guardian of the health of mankind, the instrument of torture, and that of the most atrocious kind? more particularly when it is considered, that some of the information, which is sought after with so much barbarity, cannot be thus acquired at all, and that the rest may be ascertained without committing murder. For the colour, smoothness, softness, hardness, and other such qualities, are not the same in the body, when dissected, as when it was found: even in bodies that have suffered no violence, these qualities externally are often changed by fear, grief, hunger, indigestion, fatigue, and a thousand other inconsiderable affections. Whence it is still more probable, that the internal organs, which are still more delicate than the external, and to which even exposure to the light is new, must be changed by the severest wounds, or rather by such fatal mangling. Nothing can be more absurd than to suppose that appearances are the same in a dying man, nay, in one already dead, as during life. The abdomen, indeed, may be opened, while a man yet breathes; but no sooner does the knife reach the thorax, and divide the transverse septum, which separates the upper cavity from the lower, (which the Greeks call the *diaphragm*, διὰφραγμα,) than he immediately expires: it is, therefore, the præcordia and viscera of

a dead man which alone the butchering physician brings to his view; and which necessarily have the appearance of the organs of the dead, and not of those of the living. Thus all that is gained by the physician is the opportunity of committing a barbarous murder, and not that of witnessing the condition of the viscera in a living man. If, however, any information can be obtained, as to the appearances of the internal parts while the individual yet breathes, accident often gives the practitioner opportunities for such observation: for it frequently happens that a gladiator in the *arena*, a soldier in battle, or a traveller attacked by robbers, is wounded in such a manner as to expose some internal organ to view; whence a sagacious physician will learn the situation, position, connection, figure, and other circumstances belonging to each, while he is endeavouring to relieve, and not to murder the patient; and thus will acquire, through compassion, that knowledge which others have obtained by the most horrid cruelty. Moreover, it is clear, from the arguments already stated, that it is not necessary to mangle even dead bodies; which, though not cruel, is loathsome to the sight, as are most of the circumstances connected with the dead; and whatever can be learned, respecting the living, may be acquired during the treatment of their diseases and wounds." See Celsus, De Medicina, in Præf.

The concluding observations, which deny the necessity of anatomical knowledge, acquired by the dissection of dead bodies, appear to be the only point in the tenets of the empiric physicians which is liable to dispute. But even in this point, we are satisfied, there is a great portion of truth, so far as relates to the knowledge and treatment of those internal diseases, to which the knife of the surgeon cannot reach; for the knowledge of the appearances and connection of the viscera does not enable us to suggest the practical means of relief, when they become diseased: experience and observation alone, as the empirics contend, have taught us to apply the remedies. See an Essay on the Importance of Anatomical Knowledge to Medicine, in the Edinburgh Med. and Surg. Journal for Jan. 1809.

After having thus stated the doctrines of the empiric physicians, in opposition to those of their opponents, Celsus has subjoined a sensible and judicious criticism respecting the merits of both. But this is not the place to enter more fully into the subject; we must therefore refer those, who wish for the opinion of that classical physician, to his work already quoted.

There is one point, which could not be well introduced under any of the preceding heads, which the dogmatists constantly threw out against the empirics, namely, that *new* diseases occasionally occur, for the cure of which, consequently, practice and experience have afforded no rules or information; whence, they say, it is necessary to investigate their causes, both evident and occult, without a knowledge of which no mortal can find out why one curative expedient ought to be adopted rather than another. But the reply of the empirics to this point is not less accurate and satisfactory than in the preceding parts of the dispute. "New diseases," they say, "requiring new remedies, seldom if ever occur; but if any unknown disorder should appear, the physician would not require the hypothetical doctrines about occult causes to direct him in his method of treatment: he would immediately observe to what known disease it was most nearly allied in its nature and symptoms, and employ the remedies which experience had shewn to be successful in the similar malady; and by such resemblance he would be able to discover a proper remedy." Celsus.

It is evident, then, that both the dogmatic and empiric physicians appealed to experience, and that neither excluded altogether the dictates of reason and reflection. The principal difference in their tenets appears to have consisted chiefly in this: that the empirics reasoned only from the facts ascertained by observation, without attempting to explain their essential and inscrutable nature by hypotheses; and that the latter speculated upon the mode and nature of every action and phenomenon in the animal body, and took these speculations as the basis of their reasoning:—an error in the investigation of nature, which, as we have before said, was so well exposed by lord Bacon, in modern times; and which was practically illustrated in the triumph of Newton's empiric doctrines, over the hypotheses of Des Cartes.

No longer engaged in studying systems, and averse to speculation, even in regard to the symptoms of diseases, the empirics exerted their whole faculties in investigating the power of medicinal substances, which laid the foundation of their pre-eminence in pharmaceutical skill, and gradually effected those changes in the art of medicine which subsequently occurred. The properties of the productions of nature, especially of the vegetable world, were extensively examined; and the instruments of the physician, by which he could influence the functions of the living body, were greatly multiplied. It is chiefly to the industry of the ancient empirics that we are indebted for the introduction, or rather for the full knowledge, of sedative and narcotic remedies; on the liberal use of which probably depended the superior reputation acquired by some of them over their more cautious antagonists. Of this superiority, a singular instance occurs in the many existing testimonies to the fame of Heraclides of Tarentum, before mentioned, who is recorded as the most successful physician in any age or country of the world.

It is easy to see, however, that this direction of medical inquiry, given by the empiric physicians, to the discovery of the qualities of medicinal substances, or drugs, would in all probability lead to many abuses and evils. Experiment of this sort being much easier, at least when carelessly made, than that unremitting and accurate observation of the phenomena of diseases, which alone can constitute the scientific physician, the ignorant and idle would content themselves with pharmaceutical experiments, and neglect the task of pathological investigation; and selfish craft and dishonesty would soon learn to impose on the credulity of the people, in the administration of secret remedies, when the use of a particular drug, and not the general treatment of a disease, was supposed to be the essence of medicine. Hence it actually happened, even in the early ages of physic, that these ignorant and illiberal pretenders to panaceas, and infallible remedies, who did not know one disease from another by its symptoms, appeared in Egypt, Greece, and Arabia, and were much complained of by their more rational contemporaries. In all succeeding ages, the race of these illiterate pretenders has been multiplied, under the abused name of *empirics*. In our own time, indeed, while a college of physicians, constituted by royal and parliamentary authority, exists in the metropolis, for the regulation of the practice of medicine, and the prevention of the mischiefs occasioned by nostrum-mongers, and pretenders of all kinds, *quackery* thrives, unmolested by the college, and sanctioned, licensed, and protected by patent, on the part of government, to an extent heretofore unexampled. See *Cl. Hist. de la Med.* Schulzii *Hist. Med. Cels.* in *Præf. Galen.* *Loc. Cit.* Walker's *Mem. of Medicine*.

**EMPIRIC**, in *Modern Medicine*, is applied to a person, who sells or administers a particular drug, or compound, as

a remedy for a given disorder, without any consideration as to the variations of that disorder, in its different stages, or degrees of violence, or as it occurs in different constitutions, climates, or seasons, or in persons of different age, sex, strength, &c. Such a practice implies a total ignorance of the nature of the human constitution, both in health and disease; and therefore is generally found to be the resort of the illiterate and selfish, not to say dishonest, part of mankind. See the preceding article. See also *QUACK*.

**EMPIS**, in *Entomology*, a genus of dipterous insects. The mouth is furnished with an inflected sucker and proboscis; sucker with a single-valved sheath and three bristles; feelers short and filiform; antennæ setaceous. These are carnivorous, and subsist on flies and other small insects, which they seize with their feet, and pierce with their rostrum, to suck the blood and juices of their body. Some of the species are found on flowers, in the winged state: None of the larvæ are known.

#### Species.

**BOREALIS**. Black; wings subrotund and ferruginous-brown. Linn.

Inhabits Sweden, Britain, and various other parts of Europe, and is often seen in swarms in the air, like the gnat, on a still evening, about sun-set.

**PENNIPES**. Black, with the posterior legs long and feathered. Fabr. *Afilus pennipes*, Scop. Ent. Carn. 994.

Found in Europe, on the geranium sylvaticum and cardamine pratensis. A supposed variety is described by Linnæus, which has the four posterior thighs feathered, and the wings brown, with a black rib.

**MARGINATA**. Black; wings white, with black margin. Fabr.

A small species, found in Saxony.

**MAURA**. Black; shanks of the fore-legs thick and ovate. Fabr.

Inhabits environs of Hamburg, about stagnant waters.

**LIVIDA**. Livid; thorax pale-green, with three black lines; base of the wings and legs ferruginous. Fabr.

Frequent on the flowers of the cow-parsnip (*heracleum sphondylium*) in Europe. The wings are oblong, and veined with fuscous.

**CILIATA**. Blackish; wings with fuscous rib; legs black, four posterior ones feathered. Fabr.

Inhabits Europe, and in size resembles the last. The head is black, with a testaceous proboscis; thorax hairy.

**CINEREA**. Cinereous; thorax immaculate; legs pale; wings at the tip brownish. Fabr.

Inhabits Sweden, on umbellate flowers.

**MACULATA**. Cinereous; snout, sides of the abdomen, and legs testaceous; wings spotted. Fabr.

Native of Italy. The thorax is cinereous, with faint lines; legs testaceous, with black claws; abdomen with a testaceous line on each side.

**STERCOREA**. Testaceous, with a dorsal black line; wings reticulated. Linn. Fn. Succ.

On umbellate flowers, in Europe.

**MINUTA**. Black; legs testaceous; wings white. Fabr. Inhabits Denmark, on fungi. Small.

**CRASSIPES**. Black; all the shanks with a long thick joint; wings white, lower half of the outer margin black. Schranck.

Very small, and inhabits Austria.

**RUFIPES**. Black, and somewhat cinereous, legs ferruginous. Linn.

Native of Europe.

**QUADRILINEATA**. Black, and somewhat greyish; thorax

thorax with four lines; abdomen cylindrical, with the tip inflected. Linn.

Inhabits Europe.

**TRILINEATA.** Cinereous; thorax with three black impressed lines; wings white; legs pale-yellow. Linn.

Abdomen sometimes yellow, sometimes fuscous. This and the three following species inhabit Europe.

**NIGRICUS.** Cinereous; thighs black; shanks and wings ferruginous. Linn.

**GIBBOSA.** Fuscous; thorax gibbous; abdomen thin; wings spotted; shanks and ends of the legs white. Linn.

**FUSCIPES.** Brown-cinereous; wings white; legs livid; feet fuscous. Linn.

**LEUCOPTERA.** Thorax cinereous; abdomen black; wings white; legs livid. Linn.

**EMPLASTICS**, in *Pharmacy*, are salves, or medicines, which stop up and constrict the pores of the parts they are applied on; otherwise called *emphraclics*.

The word is formed from the Greek, *εμπλασσειν*, to stop up.

Such are fats, mucilages, wax, the whites of eggs, &c.

**EMPLASTRA AMYNTICA.** See **AMYNTICA**.

**EMPLASTRUM**, popularly called *plaster*, a medicine of a stiff, glutinous consistence, composed of divers simple ingredients, spread on leather, or linen, and applied externally.

The word is formed from the Greek, *εμπλαστῶν* or *εμπλασσω*, to put in a mass, or to smear over, because the em-plaster is made of divers kinds of simple drugs, worked up into a thick tenacious mass; or because it covers over the piece of leather or linen to be applied on the part affected.

Emplasters are made up in a strong solid body, that by remaining a long time on the part, the medicinal ingredients they are chiefly composed of, may have time enough to produce their effect.

The drugs used to give a body and consistence to em-plasters, are usually wax, pitch, gums, fats, litharge, and other preparations of lead.

There are emplasters of divers kinds, and used with divers intentions; stomachic emplasters; cephalic, styptic, hepatic, diaphoretic, resolutive, detergent, emollient, incarnative, astringent, conglutinative, &c. emplasters.

In the prescription of extemporaneous plasters, the greatest regard is to be had to that particular consistence which the part can most conveniently bear, whereupon the application is to be made. Thus, plasters to the breast and stomach, especially in the intention of emollients or discutients, should be yielding and soft, as in the officinal *emplastrum stomachicum*; but to the loins, or any of the limbs, where warm discutients and strengtheners are to be applied, an higher and more adhesive consistence is to be sought for. The emollient plasters likewise should be laid on thick, and frequently repeated, if the symptoms continue, because their better parts are soon spent. Discussants also applied to hard tumours, require repetition; but the strengtheners, which are purposely contrived of a strong adhesive consistence, are permitted to lie on till they grow dry, and come off spontaneously. In some stultent tumours, where a plaster alone will not prevail, they are at intervals taken off, and discutient fomentations or lotions made use of; such as are composed of bitters, carminatives, comprehending also lixivial salts or alkaline spirits.

**EMPLASTRUM Adhesivum**, *Adhesive Plaster*, now called "*Emplastrum lithargyri cum resinâ*," or "*litharge-plaster with resin*," is composed of three pounds of litharge or common plaster, with the proportion of half a pound of

yellow resin; and is prepared by melting the litharge plaster with a slow fire, and mixing the powered resin. The black sticking-plaster, called the lady's court-plaster, is formed by dissolving twelve ounces of the gum benjamin in twelve ounces of rectified spirit of wine, and straining the solution. In a separate vessel, dissolve a pound of the best isinglass in five pints of pure water; and after straining this solution, mix it with the former, and let them stand in a narrow vessel, that the grosser parts may subside: when the liquor is cold, it will become a jelly, which will melt near the fire when it is to be spread. This quantity will be sufficient for spreading on ten yards of half-yard wide silk; in order to which, the silk must be stretched in a frame, and the mixture may be spread upon it with a sponge or brush, which should be done near a fire. As each spreading dries, it must be repeated to the tenth or twelfth time, and then touched lightly with a brush to give it a gloss. The following more simple preparation may be substituted for the former; dissolve a pound and a quarter of fine isinglass in five pints of water, and before it cools spread it on silk in the manner above directed:

**EMPLASTRUM ex Ammoniaco cum Mercurio**, now called "*Emplastrum ammoniaci cum hydrargyro*," a form of medicine, ordered to be prepared in the following manner.

Take gum ammoniacum, strained, a pound; purified quicksilver, three ounces by weight; sulphurated oil, one dram by weight, or q. s. Rub the quicksilver with the sulphurated oil till the globules no longer appear; then add by degrees the gum ammoniac melted, and almost cooled again, and make the whole into a plaster.

This plaster is recommended in pains of the limbs, arising from a venereal cause. Indurations of the glands, and other violent tumours, are likewise found sometimes to yield to it.

**EMPLASTRUM Anodynum**, *Anodyne Plaster*, is prepared by melting an ounce of the adhesive plaster; and, whilst it is cooling, mixing with it a dram of powdered opium, and the same quantity of camphor previously rubbed up with a little oil. This plaster gives relief in acute pains, especially of the nervous kind.

**EMPLASTRUM Attrahens**, the *Dracoining Plaster*, now "*Emplastrum cereæ compositum*," a plaster ordered to be now made in this manner: take yellow wax and prepared mutton suet, of each three pounds; and yellow resin, one pound: melt all together, and strain the mixture while it is hot.

**EMPLASTRUM Cephalicum**, or "*Emplastrum picis Burgundicæ compositum*," is composed of Burgundy pitch, two pounds; ladanum, one pound; yellow resin and yellow wax, of each four ounces by weight; and expressed oil of nutmeg, one ounce by weight: to the pitch, resin, and wax, melted together, add first the ladanum, and then the oil of nutmeg.

**EMPLASTRUM Commune**, or "*Emplastrum lithargyri*," litharge plaster, a name given to what has been long called *diachylon-plaster*. It is ordered to be made of a gallon of oil of olives, and five pounds of litharge in very fine powder, boiled together on a slow fire, with about a quart of water, to keep them from burning, till they are perfectly mixed, and have the consistence of a plaster.

This plaster is generally applied to slight wounds and excoriations of the skin; it keeps the part soft and warm, and defends it from the air, which is all that is necessary in such cases.

**EMPLASTRUM Commune cum Mercurio**, or "*Emplastrum lithargyri cum hydrargyro*," is made in the same

manner as the ammoniacum-plaster with quicksilver, of litharge-plaster, one pound; purified quicksilver, three ounces by weight; and sulphurated oil, one dram by weight, or q. f.

**EMPLASTRUM *é* Cymino**, or "Emplastrum cumini," is composed of cummin, caraway, and bay-berries, of each three ounces by weight; Burgundy pitch, three pounds; and yellow wax, three ounces by weight. Let the pitch be melted with the wax; powder the rest, and mix all together.

**EMPLASTRUM Gummi**, *Gum Plaster*, now called "Emplastrum lithargyri compositum." Take of the common or litharge plaster, three pounds; strained galbanum, eight ounces by weight; common turpentine, ten drams by weight; and frankincense, three ounces by weight. Melt the galbanum with the turpentine, and mix with them, first, the powdered frankincense, and then the litharge plaster, previously melted with a slow fire. This is used as a digestive, and for discussing indolent tumours.

**EMPLASTRUM Roborans**, the *Strengthening-Plaster*, now called "Emplastrum thuris compositum," or compound frankincense plaster, is ordered to be made thus: take of the common or litharge-plaster, two pounds; of frankincense, half a pound; and dragon's blood, three ounces by weight: melt the plaster, and then add to it the other ingredients in powder.

**EMPLASTRUM Saponis**, *Soap-Plaster*, is made by mixing half a pound of soap with three pounds of melted litharge-plaster; and boiling them to the consistence of a plaster.

**EMPLASTRUM Stomachicum**, *Stomach-Plaster*, or "Emplastrum ladani compositum," is composed of ladanum, three ounces by weight; frankincense, one ounce by weight; cinnamon, powdered, expressed oil of nutmeg, of each half an ounce by weight; and oil of spearmint, one dram by weight. To the melted frankincense add, first, the ladanum softened by heat, and then the expressed oil of nutmeg. Mix these and the cinnamon with the oil of mint, and beat them together in a warm mortar. Let it be kept in a close vessel. An ounce or two of this plaster, spread on soft leather, and applied to the region of the stomach, will be of service in flatulencies, arising from hysteric and hypochondriac affections.

**EMPLASTRUM, Vescicatorium, Blistering-Plaster**, or "Emplastrum cantharidis," is formed by melting two pounds of plaster of wax, and half a pound of prepared hog's lard; and a little before they coagulate, sprinkling one pound of cantharides, finely powdered. In order to render blistering-plasters efficacious, care should be taken that the flies be good, fresh powdered, and the powder fine; and that the plaster should neither be made in too great quantity at once, nor spread with a spatula too much heated. See **BLISTER**.

**EMPLEURUM**, in *Botany*, from *επι*, in or upon, and *πλευρα*, the side, alluding to the lateral insertion of the stigma upon the germen. Soland. in Ait. Hort. Kew. v. 3. 513. Schreb. 812. Willd. Sp. Pl. v. 4. 333. Mart. Mill. Dict. v. 2. Juss. 298. Clafs and order, *Monocleia Tetrandria*. Nat. Ord. *Rutacee*, Juss.

Gen. Ch. Male. *Cal.* Perianth of one leaf, bell-shaped, four-cleft, permanent. *Cor.* none. *Stam.* Filaments four, thread-shaped, equal, simple, longer than the calyx, a little spreading; anthers erect, oblong, obtuse, somewhat quadrangular, of two cells, each bursting by a lateral siffure. Abortive germen sometimes present. Female on the same plant. *Cal.* as in the male. *Cor.* none. *Pist.* Germen inferior, oblong, compressed, of one cell, terminated by an erect leafy appendage; style none; stigma placed on a

lateral tooth at one edge of the germen, erect, cylindrical, smooth, deciduous. *Peric.* Capsule oblong, compressed; crowned with a leafy oblique appendage, of one cell, bursting at its straightest edge. *Seed* solitary, oblong, inserted laterally, enclosed in a bivalve, elastic, rigid arillus.—Very rarely two capsules are said to be found in one calyx.

Ess. Ch. Male, Calyx four-cleft. Corolla none. Sometimes with the rudiment of a germen. Female, Calyx four-cleft, inferior. Corolla none. Stigma cylindrical, standing on a lateral tooth of the germen. Capsule beaked, of two valves. Seed solitary, with an elastic arillus.

*E. ferrulatum*. Soland. in Ait. Hort. Kew. v. 3. 340. Sm. Exot. Bot. v. 2. 7. t. 63. (*Diosma unicapularis*; Linn. fil. in Suppl. 155. D. ensata; Thunb. Prod. 43.) This is the only species hitherto observed. Native of the Cape of Good Hope, where Thunberg, Masson, and others have gathered it. Masson sent it to Kew in 1774. It requires the shelter of a green-house, and the same treatment as other Cape plants of the Rutaceous order, *Diosma*, *Eriogonon*, &c. but is less ornamental than most of them, on account of the want of petals. The stem is shrubby, and much branched. Leaves ever-green, smooth, shining, alternate, almost sessile, linear-lanceolate, acute, bordered with shallow glandular ferratures, destitute of stipulas. Flowers on simple, axillary, clustered stalks, reddish, but inconspicuous. Capsules more striking, from their enlarged leafy termination. The whole plant, when bruised, smells strongly of rue or juniper, like most of its natural order. See **DIOSMA** and **ERIOSTEMON**.

**EMPNEUMATOSIS**, from *εμπνεω*, I inflate, in *Medicine*, a word used by some writers to signify an inflation of the stomach; but by others, in a more general sense, for inflations of the womb, or of any other part.

**EMPOLI, JACOPO DA**, in *Biography*, a painter of the Florentine school, who was born at Empoli, as his name designates, in 1554; and was first instructed in his art in the school of Maso di San Friano. He afterwards applied himself to study the works of Andrea del Sarto, and with very considerable success, acquiring very much his style of design, and hues and tones of colouring. He copied Del Sarto's works very closely, and not only his, but those of other masters, with so much accuracy, as to deceive the judgment of those well versed in the art. So much talent for this kind of exercise in art, is seldom accompanied by a power of invention or execution of original works. But Empoli had considerable reputation for this also, and his compositions are spoken of as possessing much spirit and ingenuity, and also exhibiting considerable feeling of beauty and elegance.

**EMPOLI**, in *Geography*, a town of Italy, in the duchy of Tuscany, situated on the Arno; 15 miles W. of Florence.

**EMPORETICA CHARTA**. See **CHARTA** and **PAPER**.

**EMPORIA**, in *Ancient Geography*, a country of Africa, on the Lesser Syrtis, in which Leptis stood. This territory was under the dominion of the Carthaginians, and was put under contribution by Masinissa. Leptis is said to have paid a talent *per* day to the Carthaginians. No part of the Carthaginian dominions was more fruitful than this. Polybius (l. i.) says, that the revenue which arose from hence was so considerable, that all their hopes were almost founded on it; and he deduces the origin of its name from its great fertility, and the commerce which distinguished it. To this were owing the anxiety and state-jealousy of the Carthaginians, lest the Romans should sail beyond the fair promontory, that lay before Carthage, and become acquainted with a

country which might induce them to attempt the conquest of it.

**EMPORIÆ, AMPOURIAS**, a town of Hither Spain, which lay towards the south, and which was, as its name imports, a commercial port. Strabo says, that the Massilians were established here: but Pliny and Silius Italicus say, that they were the Phocæans; both which reports may agree, as the inhabitants of Marseilles profess to have derived their origin from the Phocæans. According to Livy, this place consisted of two towns separated by a wall; that on the sea-coast, encompassed by a wall of 400 paces, was inhabited by Greeks, a colony of Massilians, who sprung from the Phocæans; and the other part, which had no communication with the sea, was surrounded by a wall of 3000 paces. This historian informs us, that Cæsar, after having defeated Pompey's party, established a body of Romans in this place. The Greeks, who were established in this place, had previously inhabited a small island opposite to it, from which they passed over to the continent. They worshipped Diana of Ephesus.

**EMPORICUS SINUS**, a gulf of Africa, in Mauritania. Ptolemy places it in the Adriatic sea, at  $34^{\circ} 20'$  of latitude.

**EMPORIUM**, a fortress of Italy, in Emilia, 5 miles from the Po.—Also, a place of Macedonia.—Another of Sicily.—Another of Italy, in Campania.—Another in Celtica. Steph. Byz.

**EMPORIUM**, in *Physiology*, is often used for the common sensory in the brain. See **BRAIN**.

**EMPRIMED**, among *Sportsmen*, a term applied to a hart, when he forsakes the herd.

**EMPRION**, from  $\epsilon\mu\pi\rho\iota\omega$ , to saw, in the *Medical Writings of the Ancients*, a word used to denote a peculiar pulse, in which the artery is felt to be distended in one part more than another at every stroke, and by that means is made to resemble any serrated body, or the light teeth of a fine saw.

**EMPROSTHOTONOS**, in *Medicine*, from  $\epsilon\mu\pi\rho\sigma\theta\omicron\tau\omicron\nu\omicron\varsigma$ , forwards, and  $\tau\epsilon\iota\nu\omega$ , I stretch, is the term applied to that form of tetanus, or general spasm, in which the muscles which bend the body forwards are most strongly affected, so that the whole body is rigidly fixed in a bent position, the neck and back being bowed forwards, the chin fixed upon the breast, &c. The term is used in opposition to **OPISTHOTONOS**, in which the body is bent backwards. (See **TETANUS**.) The emprosthotonos, however, is a very rare occurrence; and some writers have altogether denied its existence, except as a partial affection confined to the neck.

**EMPTOR FAMILIÆ**, *buyer of a family*, in the *Roman Law*, one who purchased the inheritance of a person, or the privilege of being appointed his heir by will.

This was done by the ceremony of scales and weights, before five witnesses, with the use of a peculiar formula of words.

Such buyer differed from the heir, *heres*, as the testator in some measure alienated the right to the former during his own life-time, whereas the latter had only a right by his death. Brisson. de Formul. lib. vii. p. 585. Pitisc. Lex. Ant. tom. i. p. 713. voc. *Emptor*.

**EMPTOR FIDUCIARIUS**, *fiduciary buyer*, one who receives a thing in the way of pledge, till the money he has advanced be repaid. Salmat. de Mod. Usur. cap. 14. Pitisc. Lex. Ant. tom. i. p. 713. voc. *Emptor*.

**EMPTYSIS**, in *Surgery*, bleeding from the mouth and fauces.

**EMPUS**, in *Geography*, a town of France, in the de-

partment of the Var, and district of Draguignan; 5 miles N.W. of Draguignan.

**EMPUSA**,  $\epsilon\mu\pi\upsilon\sigma\alpha$ , among the *Ancients*, a kind of hobgoblin, or bugbear, under the direction of Hecate, who used to send it to frighten people who laboured under misfortunes. Hofm. Lex. in voc.

**EMPYEMA**, in *Surgery*, signifies a collection of matter in the cavity of the thorax. The term is derived from  $\epsilon\mu$ , within, and  $\pi\upsilon\sigma$ , pus, or matter.

The ancients made use of the word "empyema" to express every kind of internal suppuration. Ætius first employed the term to denote the collections of purulent matter, which sometimes form in the cavity of the pleura, or membrane lining the chest; and all the best modern surgeons invariably attach this meaning alone to the expression.

The operation for empyema means the making of an opening into the thorax, for the purpose of giving vent to the matter collected in the cavity of the pleura. The necessity for having recourse to such an operation, however, does not often present itself. We would not wish to be thought to assert, that inflammation of the lungs, pleura, mediastinum, diaphragm, and even of the liver, does not sometimes terminate in suppuration. Certainly, the latter event is occasionally produced; but, when it does happen, the matter does not always make its way into the cavity of the chest. Very frequently external abscesses form, or the pus is either coughed up, or discharged with the stools.

When the surface of the lungs and pleura costalis have become adherent together, in the situation of the abscess, the pus, always disposed by a law of nature to make its way to the surface of the body, occasions ulceration of the intercostal muscles, and collects on the outside of them. An abscess of this kind comes on with a deep-seated pain in the part affected; an œdematous swelling, which retains the impression of the finger; and a fluctuation, which is at first not very distinct, but from day to day becomes more and more palpable, and, at length, leads the surgeon to make an opening to let out the matter.

If an opening be not made, when the fluctuation becomes perceptible, there is some risk of the matter insinuating itself into the chest, in consequence of the adhesion being in part destroyed by ulceration. M. Sabatier affirms, that the case may take this course, even when the abscess has been punctured, and while a free external opening exists. This experienced surgeon had occasion to remark such an occurrence in a soldier. The patient had a collection of matter in the thorax, which was only indicated by a pain all over the side; a difficulty of lying in any other position in bed, than on the back; and an undulating noise in the chest, whenever he altered his posture. When M. Sabatier made the patient hold his breath, the discharge, which was very copious, was not increased; the pus did not contain any bubbles of air; there was no emphysema round the wound; nor any blast of air from it in the motions of respiration. On opening the body, M. Sabatier found, that the abscess had been originally situated between the intercostal, and the pectoralis minor, and major, muscles, and that the matter had made its way, by several ulcerated openings, into the chest. The lung, in some places, was adherent to the pleura. The quantity of effused matter was very considerable. See *Medecine Opératoire*, tom. 2. p. 249.

In the same manner, if inflammation should occur in the anterior mediastinum and end in suppuration, the abscess may possibly burst into neither of the cavities of the chest; but make its way outward, after having rendered the sternum carious. The following case, illustrative of this fact,

fact, is taken from Van Swieten's Commentaries on Boerhaave's 895th Aphorism.

A young man was attacked with a violent pleurisy, which seemed to terminate in copious expectorations, which began about a fortnight after the commencement of the indisposition, and continued for a long while. The patient became exceedingly reduced, and his fate seemed inevitable. In the tenth month of his illness, however, a small soft swelling, about the size of a filbert, made its appearance upon the middle of the sternum, the substance of which bone appeared to be obviously carious round the margin of the tumour. The swelling burst of itself, and a discharge of matter ensued. Pus continued to be emitted from the opening for eight months. The cavity of the abscess was capable of containing a pint of the fluid, which was used as a detergent injection. The matter had collected between the pleura and the ribs. The patient recovered of this alarming disease, and was seen by Van Swieten in good health, eight months afterwards. There only remained a small fistulous opening, from which an inconsiderable quantity of matter continued to be discharged.

The foregoing case of abscess in the anterior mediastinum originated from an internal cause. It was the consequence of a violent pleurisy, or rather of a similar disorder, which is attended with nearly the same symptoms, but has a different situation, and has been very accurately described by Salus Diverius. The same sort of abscess may arise, in consequence of a wound in the forepart of the chest. An interesting case of this description is related by Galen. A young man, who had been wounded in the region of the sternum, seemed to have got completely well. An abscess then formed in the situation where the injury was received; it was opened, and healed. The part, however, soon inflamed and suppurated again. The place could not now be healed. A consultation was held, at which Galen attended. As the sternum was obviously carious, and the pulsation of the heart was visible, every one was afraid of undertaking the cure of the case, since it was conceived, that it would be necessary to open the thorax itself. Galen, however, engaged to manage the treatment without making any opening of the kind alluded to, and he expressed his opinion, that he should be able to effect a cure. Not finding the bone so extensively diseased, as was apprehended, and the mammary vessels being found, he began to indulge considerable hopes of success. After the removal of a portion of the bone, he saw the heart quite exposed, by reason of the pericardium having been destroyed by the previous disease. The patient, after the operation, experienced a speedy recovery.

M. J. L. Petit met with a case of an abscess in the mediastinum, in consequence of a gun-shot wound, in the situation of the sternum. The injury had been merely dressed with some digestive application; no dilatation, nor any particular examination of the wound had been made. The patient, after being to all appearances quite well, and joining his regiment again, was soon taken ill with irregular shiverings, and often febrile symptoms. M. Petit probed the wound, and found the bone affected. As there was a difficulty of breathing, he suspected an abscess either in the diploe, or behind the sternum, and, consequently, he proposed laying the bone bare, and applying a trepan. This operation gave vent to some sanious matter, and, as soon as the inner part of the sternum was perforated, a glass full of pus was discharged. The patient was relieved, and afterwards recovered.

When, in consequence of inflammation, an abscess forms deeply in the substance of the lungs, the pus more easily

makes its way into the air-cells, and tends towards the bronchia, than towards the surface of the lungs, and into the cavity of the thorax. In this case, the patient spits up purulent matter. When the opening, by which the abscess has burst, is large, and the pus escapes from it in a considerable quantity at a time, the patient is in some danger of being suffocated. However, if the opening be not immoderately large, and the pus, which is effused, be not too copious, a recovery may follow. Abscesses in the substance of the diaphragm, and collections of matter in the liver, may also be discharged by the pus being coughed up from the trachea, when the parts affected have become connected with the lungs, by adhesions, and the abscesses of the liver are situated on its concave surface. When the collection of matter in the liver occupies any other situation, the abscess frequently makes its way into the colon, and the pus is discharged with the stools. Several cases of this kind are related by authors: Sabatier has recorded two in his *Médecine Opératoire*; Le Dran mentions his having seen others; and Pemberton, in his book on the diseases of the abdominal viscera, p. 36, relates the occurrence of additional instances of a similar nature.

We shall now proceed to the consideration of empyema, strictly so called. No surgical writer, with whom we are acquainted, has written with more discrimination, than Mr. Samuel Sharp, on the symptoms produced by collections of matter in the cavity of the chest. He remarks, that it has been almost universally taught, that when a fluid is extravasated in the thorax, the patient can only lie on the diseased side, the weight of the incumbent fluid on the mediastinum becoming troublesome, if he places himself on the sound side. For the same reason, when there is fluid in both cavities of the thorax, the patient finds it most easy to lie on his back, or to lean forwards, in order that the fluid may neither press on the mediastinum, nor the diaphragm. But, Mr. Sharp takes notice, that however true this doctrine may prove in most instances, there are a few (Le Dran's *Obs.* 217. vol. i. Marchetti, 65.) in which, notwithstanding the extravasation, the patient does not complain of more inconvenience in one posture, than another, nor even of any great difficulty of breathing.

On this account, observes Mr. Sharp, it is sometimes less easy to determine, when the operation is requisite, than if we had so exact a criterion, as we are generally supposed to have. However, he informs us, that though this may be wanting, there are some other circumstances, which will generally guide us with a reasonable certainty. He states, that the most infallible symptom of a large quantity of fluid in one of the cavities of the thorax, is a preternatural expansion of that side of the chest, where it lies; for in proportion as the fluid accumulates, it will necessarily elevate the ribs on that side, and prevent them from contracting so much in expiration as the ribs on the other side. Mr. Sharp refers also to Le Dran's *Observ.* 211. vol. i. to prove, that the pressure of the fluid on the lungs may sometimes be so great, as to make them collapse, and almost totally obstruct their action. When therefore, says Mr. Sharp, the thorax becomes thus expanded after a previous pulmonary disorder, and the case is attended with the symptoms of a suppuration, it is probably owing to a collection of matter. The patient, he observes, will also labour under a continual low fever, and a particular anxiety from the load of fluid.

Mr. Sharp also observes, that, besides this dilatation of the cavity from an accumulation of the fluid, the patient will be sensible of an undulation; and sometimes the undulation is so evident, that a by-stander can plainly hear it in certain motions of the body. Mr. Sharp adds, that this

## EMPYEMA.

was the case with a patient of his own, on whom he performed the operation; but the fluid, in the example alluded to, he says, was very thin, being a serous matter, rather than pus.

According to the same author, it will also frequently happen, that though the skin and intercostal muscles are not inflamed, they will become œdematous in certain parts of the thorax; or if they are not œdematous, they will be a little thickened. These symptoms, joined with the enlargement of the thorax, and the preceding affection of the pleura or lungs, seem unquestionably to indicate the propriety of the operation. But, observes Mr. Sharp, amongst other motives to recommend it upon such an emergency, this is one, that if the operator should mistake the case, an incision of the intercostal muscles would neither be very painful, nor dangerous. See *Critical Enquiry into the present State of Surgery*; sect. on Empyema.

Although we would wish the reader to understand, that patients with empyema can sometimes lie in any position, without any particular aggravation of the difficulty of breathing, yet, we must distinctly state, that the generality of patients with this disease cannot place themselves on the side opposite to that where the collection of pus is situated, without having their respiration very materially obstructed. Another circumstance, also, which we wish to mention, now that we are treating of the symptoms of empyema, is, that the œdema of the integuments is sometimes not confined to the thorax, but extends to more remote parts, on the same side of the body as the collection of matter. Both the foregoing remarks are confirmed by an interesting case, which Mr. Hey, of Leeds, has lately published.

Sept. 3, 1788, Mr. Hey was desired to visit John Wilkin-son, who had been ill, ten days of the influenza. The patient was found labouring under a fever, attended with cough, difficulty of breathing, and pain in the left side of the thorax. He was bled once; had repeated blisters applied to the thorax; took nitre and antimonials, with a smooth linctus to allay his cough. He was repeatedly relieved by these means, especially by the application of the blisters; but repeatedly relapsed. At last, he became so ill, that he breathed with the utmost difficulty, and "could not lie on the right side without danger of immediate suffocation."

Mr. Hey found the patient in the state just now described on the 17th of September. "His face, and especially the eye-lid, were a little swollen on the left side." The left side of the thorax was larger than the right, and its integuments were œdematous. Upon pressing the intercostal muscles they felt distended; they yielded a little to a strong pressure, and rebounded again. The abdomen, especially at its upper part, appeared to be fuller than in its natural state. See *Practical Observations in Surgery*, p. 476.

Another remarkable symptom, which is occasionally produced by collections of matter in the chest, is an alteration in the position of the heart. Mr. Samuel Cooper has made mention of a patient who was in St. Bartholomew's hospital, whose heart was pushed quite to the right side of the chest, by an empyema in the left bag of the pleura, and pulsated on the right of the sternum. *First Lines of the Practice of Surgery*; part 2. chap. 29.

The symptoms of empyema are frequently very equivocal, and the existence of the disease is generally somewhat doubtful. Panarolius opened a man, whose left lung was destroyed, at the same time that the thorax contained a considerable quantity of pus. Although the patient had been ill for two months, he had suffered no difficulty of breathing, and had had only a slight cough. *Le Dru met*

with a case of nearly the same kind. A patient who had been for three days affected with a considerable oppression, and an acute pain on the left side of the chest, got somewhat better. He felt no material difficulty of breathing, on whatever side he lay. The only thing which he complained of, was a sense of a fluctuation in his thorax, and a little obstruction to his respiration, when he was in a sitting posture. These symptoms did not seem sufficiently decided to justify the operation, and it was delayed. The febrile symptoms continued with cold sweats, and the patient died on the eighth day. Five pints of pus were found collected in the chest.

With respect to opening such abscesses as present themselves at some part of the parietes of the thorax, in consequence of a pleurisy, or an inflammation of the diaphragm, or mediastinum, it is not attended with any peculiarity. It should be done as soon as a fluctuation can be felt, and the aperture should be made of sufficient size to give free vent to the matter. As some of these abscesses communicate with the external surface of the lungs, and others with that of the liver; as some of them are accompanied with a caries of the ribs, or the cartilages of these bones, while others are attended with an alteration of the substance of the sternum; the cure must frequently be interrupted by unpleasant symptoms, and very often retarded for a long while, especially when there are some pieces of bone to exfoliate.

We shall next consider the operation for empyema, in the common signification of this term.

Mr. Samuel Sharp advises the incision to be made between the sixth and seventh ribs, half way from the sternum towards the spine; which, says he, though not the most depending part of the thorax, when we are erect, yet is situated sufficiently low to give issue to the fluid, when we lie down.

This author was certainly mistaken in his opinion, that the expansion of the lungs always propelled the pus out of the wound, but the action of such muscles, as diminish the capacity of the thorax, may undoubtedly produce this effect. The reader, on looking over the article ΕΜΠΥΣΕΜΑ, will be perfectly convinced, that the lungs cannot become distended with air, and expanded on one side, while, on this side of the chest, there exists a free communication between the outward air and the cavity of the pleura.

Mr. Sharp quotes the practice of Marchetti, who always made the opening between the fifth and sixth ribs, to confirm the prudence of choosing this situation for the incision. See *Critical Enquiry*, &c.

A great many of the most eminent writers on the operations of surgery have had hardly any other object in view, in the operation for empyema, than making an opening into the thorax in such a situation, as would be a most depending one, in the erect position of the body. Hence these authors even sanction and recommend the unnecessary plan of cutting through the muscles of the back to make an issue for the matter in the exact place, which, according to their principle, ought to be chosen. We are sorry, that the respectable names of Bertrandi and Sabatier might be adduced in favour of this mode of proceeding.

The safest, and most convenient situation, for making an opening into the chest, is between the sixth and seventh true ribs, on either side, as circumstances may render necessary. The surgeon should only recollect, that the two cavities of the pleura are completely distinct from each other, and have no communication whatsoever, so that, if fluid were contained on the left side of the thorax, making an opening into the right cavity would not serve for discharging the accumulated matter. The practitioner should also remember,

remember, that, when there is a fluid on both sides of the chest, paracentesis must never be done for the relief of the two collections at the same time; because, there is great reason to believe, that, as the lungs on one side usually collapse, when there is a free communication between the air and inside of the thorax, they would do so on both sides, were an opening made at the same time into each bag of the pleura. It is hardly necessary to remark, that, in this condition, the patient could not breathe and would die suffocated. The operation consists, in making an incision, about two inches long, through the integuments, which cover the space between the sixth and seventh true ribs, just where the indigitations of the serratus major anticus muscle meet those of the externus obliquus. Here it is unnecessary to divide any muscular fibres, except those of the intercostal muscles, and, by putting the patient in a proper posture, the opening that is made, will be depending enough for any purpose whatsoever. The surgeon, avoiding the lower edge of the upper rib, where the intercostal artery lies, is then cautiously to divide the intercostal muscles, till he brings the pleura into view, when this membrane is to be very carefully divided with a lancet. The instrument should never be introduced in the least deeply, lest the lungs should be injured. The size of the opening in the pleura should never be larger than necessary. The discharge of blood and matter will of course require a freer aperture, than that of air, or water. If requisite, a cannula may be introduced into the wound, for the purpose of facilitating the evacuation of the fluid, and it may, even in some cases, be proper to let this instrument remain in the part, in order to let the water, or pus escape, as often as another accumulation takes place. It is obvious, however, that a cannula, for this object, should only be just long enough to enter the cavity of the pleura, and should have a broad rim to keep it from slipping into the chest. A piece of sticking plaster would easily fix the cannula, which might be stopped up with a cork, or any other convenient thing, or left open according as the circumstances of the case, and the judgment of the surgeon, may direct.

It is proper to state, that some practitioners make the wound between the fifth and sixth ribs: thus, Mr. Hey, in relating an interesting case of empyema, informs us, that the pain which the patient had felt in his side had been most acute betwixt the fifth and sixth ribs, and that there he (Mr. H.) made an opening into the cavity of the thorax. His first incision was about two inches in length. He cut through the serratus and intercostal muscles close to the upper edge of the sixth rib, and made an opening into the chest capable of admitting the tip of his finger. A large quantity of matter was thus discharged, and a leaden cannula was introduced into the wound on the second day after the operation, and was retained in its place by a flannel bandage. Mr. Hey did not allow the patient to leave off wearing the cannula, until the discharge from the thorax had ceased, and he had completely regained his strength. He wore it fifteen months.

Mr. Hey thinks it of great consequence to retain a cannula in the wound, until all probability of relapse is removed. This precaution, he apprehends, will not hinder the patient from recovering his strength, even when the use of the instrument is not absolutely necessary. See Hey's Practical observations in Surgery, p. 477, &c.

EMPYEMATA, suppurating medicines.

EMPYI, patients with empyema.

EMPYREUM, among *Divines*, denotes the highest of the heavens, where the blessed enjoy the beatific vision; called also empyrean heaven, and paradise.

The word is formed of *εἰ* and *πῦρ*, *fire*, because of its splendour.

EMPYREUMA, in *Chemistry*, is that smell and taste of scorching which takes place in most animal and vegetable substances, when heated to that point at which decomposition by fire begins. It is always attended with a darkening of colour of substances naturally clear and limpid. The degree of heat at which this change occurs is various, but it is always above that of boiling water, so that the use of a boiling water-bath for digestions, or desiccations, is an effectual mode of preventing empyreuma. There is, however, a change that takes place in vegetable decoctions or infusions when evaporated to the consistence of an extract, however low the heat is kept, since when these extracts are again diluted to their original consistence, they differ both in sensible and chemical properties, from the original liquor. The causes of this change are, probably, in part the action of the external air, but principally, several complicated chemical actions that take place between the various component parts of the vegetable substance itself, when their particles are concentrated by evaporation of the water which held them in solution. This circumstance is often confounded with empyreuma, properly speaking, or the changes produced by heat pushed to the degree at which decomposition occurs, and as some of the effects appear to be nearly similar, it is perhaps impossible to adhere strictly to the real distinction. The leading circumstance that indicates empyreuma in vegetable and animal matters is the *charring*, or conversion into black carbon, of part of the substance thus heated, whence a carbonaceous insoluble powder is produced, which partly subsides on dilution with water, and partly remains finely suspended.

The smell and taste of empyreuma in vegetable infusions, may be in many cases got rid of by filtering through recently-burned charcoal powder.

EMPYREUMA is also used for the heat remaining upon the declension of a fever.

EMPYREUMATIC ACID and OIL, in *Chemistry*. When most animal and vegetable substances are distilled *per se* in a heat gradually urged to redness, a dark-coloured strong smelling oil almost invariably rises towards the end of the process, which is strongly empyreumatic.

Many vegetable substances yield also, at the same time, a strongly acid and empyreumatic liquor, which appears to be chiefly acetous acid generated in the process, and holding much carbonaceous matter in solution, from which it may be partly freed by a separate distillation in a gentle heat. See PYROLIGNEOUS and PYROMUCOUS ACID.

EMRODS, or rather HÆMORRHOIDS. See HÆMORRHOIDS.

EMS, in Latin *Amisia*, or *Amasus*, in *Geography*, is a considerable river of Germany, which has its source in the county of La Lippe, in Westphalia, flows through East Friesland, and falls into the North sea, near Emden. It gives its name to one of the new departments of Holland, which is the ancient province of East Friesland, whose chief place is the town of Leuwarden.

Ems, a town of Germany, in the circle of the Upper Rhine, and principality of Hesse-Darmstadt; seven miles E.S.E. of Coblenz.

EMSBACH, a river of Germany, in the circle of the Lower Rhine, which runs into the Lahn, three miles E. of Limburg, in the electorate of Treves.

EMULATION, is a generous ardour kindled by the brave examples of others, which impels us to imitate, to rival, and, if possible, to excel them. This passion involves in it esteem of the person whose attainments or conduct

we emulate, of the qualities and actions in which we emulate him, and a desire of resemblance, together with a joy springing from the hope of success.

The word comes originally from the Greek *αμιλλα*, *dispute, contest*; whence the Latin *emulus*, and thence our emulation.

Dr. Hartley refers emulation to a class of the sympathetic affections, by which we grieve for the happiness of others; and Dr. Reid, in his "Essays," (p. 167,) defines it as a desire of superiority to our rivals in any pursuit, accompanied with an uneasiness at being surpassed. He classes it, together with resentment, under the head of the malevolent affections, which, though they are parts of our constitution, given us by our Maker for good only, and, when properly directed and regulated, of excellent use, are nevertheless subject to excess or abuse, and thus become the source and spring of all the malevolence that is to be found among men. From the observations which he has introduced for the illustration of this affection, he infers, that emulation, as far as it is a part of our constitution, is highly useful and important in society; that in the wise and good, it produces the best effects without any harm; but in the foolish and vicious, it is the parent of a great part of the evils of life, and of the most malignant vices that stain human nature.

Plato observes of emulation, that it is the daughter of envy; if so, there is a great difference between the mother and the offspring; the one is a virtue, and the other a vice. Emulation admires great actions, and strives to imitate them; envy refuses them the praises that are their due; emulation is generous, and only thinks of surpassing a rival; envy is low, and only seeks to lessen him.

Perhaps, therefore, it would be more just to suppose emulation the daughter of admiration: admiration, however, is a principal ingredient in the composition of it.

EMULGENT, in *Anatomy*, a term applied to the blood-vessels of the kidneys. See *ARTERIES* and *VEINS*.

EMULSION, from *emulgere*, to milk, in *Chemistry* and *Pharmacy*, is any milky opaque liquor formed by the diffusion of any oily or resinous matter in water, through the medium either of alkalies, or of mucilage, or any other viscid matter soluble in water.

Milk itself is a natural emulsion, and when viewed in a powerful microscope is seen visibly to consist of oily particles suspended in a serous liquor. Many vegetable matters form natural emulsions when merely triturated with water, of which kind are almonds, and most of the oily nuts, the oil being held suspended by the mucilage or farina with which these substances naturally abound.

All the oils are rendered miscible with water, when rubbed with mucilage of gum arabic, or with the yolk of egg, or with a small quantity of any alkaline salt, and all these mixtures are common in pharmacy. Thick syrups also promote the diffusion of oily matters in water, but less perfectly.

This combination, however, is but temporary, as all the emulsions are decomposed by mere rest for some hours, and as besides they are very apt to ferment, they are only used in extemporaneous prescription.

The common emulsion, now called "Lac Amygdalæ," is made by beating an ounce and a half by weight of sweet almonds, with half an ounce by weight of double refined sugar, in a marble mortar, and rubbing them well together; adding gradually the quantity of two pints of distilled water, and straining the liquid. If two ounces and a half of the mucilage of gum arabic are added to the almonds whilst they are pounded in the mortar, we shall have the

arabic emulsion. These emulsions may be used as ordinary drink, in cases which require soft cooling liquors. The camphorated emulsion is prepared by grinding half a dram of camphor, and half a dozen sweet almonds together in a stone mortar, and adding by degrees eight ounces of mint water, straining the liquor, and dissolving in it half an ounce of white sugar. A table spoonful of this emulsion may be taken in fevers, and other disorders which require the use of camphor, every two or three hours.

The emulsion of gum ammoniac is made by grinding two drams of the gum with eight ounces of water poured gradually upon it till it is dissolved.

This emulsion is used for attenuating viscid phlegms, and promoting expectorations. In obstinate coughs, two ounces of the syrup of poppies may be added to it. It may be administered in a dose of two table spoonfuls, three or four times a day. The oily emulsion, prepared by mixing six ounces of soft water with two drams of volatile aromatic spirit, and an ounce of Florence oil, and half an ounce of simple syrup, is serviceable in recent coughs: in more obstinate coughs, it will be better to substitute for the aromatic spirit the paregoric elixir of the Edinburgh Dispensatory. A table-spoonful of it may be taken every two or three hours.

EMUNCTORY, in *Anatomy*, from *emungo*, to clean or wipe the nose, is any part of the body, which separates from the blood humours judged to be impure or excrementitious, and therefore hurtful. This process is supposed to purify the blood. The kidneys and skin are called the common emunctories, as they afford very copious secretions. This notion of the separation of noxious particles is built on the opinions of the older physiologists; and consequently the use of the term emunctory has at present nearly ceased.

EMUNGS, in *Geography*, one of the Pelew islands.

ENABY, a town of Sweden, in the province of East Gothland; 20 miles S. of Linköping.

ENADA, in *Ancient Geography*, a town of Palestine, in the tribe of Issachar, according to the book of Joshua.

ENÆMON, *Εναιμων*, from *αιμα*, blood, an external medicine which stops or itanches the blood; or which, by binding, cooling, or drying, closes the passages of the vessels before open, or diminishes the fluidity and motion of the blood. See *STYPTIC*.

ENÆOREMA, *Εναιωρημα*, from *αιωνω*, to exalt, expresses such contents of the urine as float about in the middle, resembling a cloud; and thence also called nubecula. See *URINE*.

ENAGARA, in *Ancient Geography*, an island of Asia Minor, in the Mediterranean sea, placed by Pliny over against Lycia, and near the isle of Crete.

ENAIM, a town of Judea, in the tribe of Judah, according to the book of Joshua.

ENALLAGE, in *Rhetoric*, a figure whereby we change and invert the order of the terms in a discourse, against the common rules of language.

The word is derived from the Greek, *εναλλαγη*, formed of *εναλλαττειν*, which signifies *to change*, as well as the simple verb *αλλαττειν*.

The grammarians too have a kind of enallage, whereby one part of speech, or one accident of a word, is put for another.

Such is the change of a pronoun, as when a possessive is put for a relative, *e. gr.* *suus* for *ejus*; or of a verb, as when one mood or tense is put for another.

ENALURON, in *Heraldry*, is used by Guillim to express a bordure charged with birds; as an enaluron of martlets,

martlets, &c. but Mackenzie charges this as a mistake arising from ignorance of the French tongue; enaluron properly signifying orle, or in manner of a bordure, and being applicable to a bearing of any thing in that form.

ENAMBUSH, in *Military Affairs*, relates to a device used for the purpose of surprizing an enemy, either on his route, or when pursuing a small body of troops sent out for the purpose of decoying him into the snare. This insidious practice is often of considerable service in the minor branches of warfare, but can rarely be practised on a great scale; though history furnishes us with instances of armies having been taken by surprize, owing to the cunning of their adversaries, in lying concealed in such places as enabled them to take advantage of an unsuspecting commander. This, however, is not what in strictness is termed an *ambush*. That term more properly is confined to that kind of preconcertion, which rather leads an enemy into the danger, by some supposed advantage held out to his acceptance, whether it be for forage, the seizing of a depot, the interception of a convoy, or the attack upon some weak post. Here we see an immense field open for contrivance and speculation. It is to be understood, that when a body of troops is placed in ambush, certain intelligence has been obtained of the numbers, route, and object of those who are to be intercepted. If these be not previously ascertained, the ambuscade may prove fatal: since, should it turn out that, instead of five hundred, five thousand were to be attacked; that, in lieu of their being foragers laden with booty, they should prove to be a body of light horse, with riflemen at their backs; or that, instead of being a detachment sent to surprize some small outpost, they should be the advanced guard of a strong column:—in either of these cases, a sad reverse would take place; for, although at the first brush, there might be some surprize, and possibly some confusion, it would in all probability be but for the moment; after which the assailed party would press forward with great eagerness, and by means of their flanking parties cover the speculators with disgrace and ruin. The most deadly kind of ambuscade is that wherein fire-arms are rejected, the whole depending upon pikes and cutlasses: in such, silence is an important object, even in the very moment of falling upon the enemy. This not only prevents the other parts of the line from being able to ascertain the exact situation of the assailants, as may always be done by observing the flashes from musketry, &c.; but renders it impossible to ascertain their numbers. Add to this, that when men fire, in the dark especially, at a moving object, they are by no means certain of their aim; nor can they so speedily recover themselves, after their pieces may have been discharged. Besides, it is well known that pikes cause infinite consternation, when coming to close quarters; being much longer than the musket with the bayonet attached, they are infinitely more destructive, when properly used in this species of warfare. In many countries, it is next to impossible to enambush the enemy; while, in others, almost every spot affords the means of concealment. The great art is, to avoid all common-place modes of laying *perdue*: such are rarely successful, owing to that invariable attention paid towards the examination of every such suspicious situation. On the other hand, those parts which are least suspected often prove particularly formidable; but where such are resorted to, the means of retreat, or at least of defence, ought to be fully established. Those ambuscades which are the most collected, always carry the greatest probability of success: they are least liable to detection, far more pointed in their attack, and most calculated for resistance, when prematurely discovered.

Cavalry is rarely employed in ambushes, though a considerable body may, if convenient, be posted in a proper direction, for the purpose of supporting the infantry concealed in woods, &c. On some occasions, it is even advantageous that such cavalry should be visible, but in an opposite quarter; so as to cause the force to be attacked to be concentrated, by calling in their scouts and videttes; by which those in ambush might else be discovered. This device likewise occasions the baggage to be sent upon the other flank, out of the way of the cavalry, and leaving that flank towards them free from incumbrance. When this happens, and that the cavalry make a shew of charging, the baggage will commonly fall into the hands of those in ambuscade. Naval ambuscades are by no means uncommon: it often happening that a well-concerted decoy lures an enemy into such a situation as at least places him under considerable disadvantage, or eventually causes him to surrender. Thus, disguising vessels by means of new painting; changing their mode of rigging; appearing to avoid rather than pursue; sending out a slow sailing vessel to pass between a cruiser and an island, behind which a superior force is concealed, &c. &c. are all *ruses de guerre* in common use. One device, which probably would otherwise be often practised, is contrary to the laws of honour and the rules of war, namely, making signals of distress, with the view to draw an enemy's vessel to give assistance, and then to capture her. To assume the appearance of being damaged, either by weather or by action, is all fair; because then the enemy bears down as upon a prey, and not as a protector. However, the practice of enambushing, whatever advantages it may seem to offer, is subject to extreme danger: unless guided by the most certain knowledge of the force to be surprized, it becomes almost invariably a losing concern, and has the pernicious tendency of creating great diffidence in the conduct of that commander by whose instructions it is made. Nor can the smallest success be hoped for, unless where the peasantry are friendly disposed, and the country around thoroughly known.

ENAMEL, in *Anatomy*, the hard substance which covers the crown of the tooth. It is described in the account of the teeth, contained in the article CRANIUM.

ENAMEL, in the *Arts*. Enamels are vitrifiable substances, and may be arranged into three classes, *viz.* transparent, semi-transparent, and opaque. The two former are chiefly employed in enamelling on gold and silver, for watch-cases, trinkets, and other small articles of jewellery; the latter is principally used on copper, for the making of clock and watch-dial plates, and for other plates which, when properly fluxed, are fit for the purpose of enamel-painting.

The basis of all kinds of enamel is a perfectly transparent and fusible glass, which is rendered either semi-transparent or opaque, by the admixture of metallic oxyds. White enamels are composed by melting oxyd of tin with the glass, and adding a small quantity of manganese, to increase the brilliancy of the colour. The addition of oxyd of lead, or antimony, produces a yellow enamel; and Kunckel affirms that a beautiful yellow may be obtained from silver. Reds are formed by an intermixture of the oxyds of gold and iron; that composed by the former being the most beautiful and permanent. Greens, violets, and blues, are procured from the oxyds of copper, cobalt, and iron; and these, when intermixed in different proportions, afford a great variety of intermediate colours. Sometimes the oxyds are mixed before they are united to the vitreous bases. Such are the principal ingredients employed in the production of the various enamels; but the proportions in which they are used, as well as the degree and continuance of the heat

heat necessary to their perfection, constitute the secrets of the art. Other substances than those here mentioned are occasionally used in the composition of enamels; and it has been said, that the peculiar quality of the best kinds of hard or Venetian enamel is owing to the admixture of a particular substance found on mount Vesuvius, and known to be thrown up by that volcano.

The work of Neri on glass, with the notes of Merret and Kunckel, afford many good precepts for making enamels; yet the exact nature and methods of composition of the best kinds, both of the hard and soft enamels, still remain among the arcana of enamelling. The soft white enamel is generally called glass, and is manufactured at the glass-house, near the site of the Albion mills, on the Surrey side of Blackfriars-bridge; the hard enamels are chiefly made at Venice, and, from the operations of the war, are not at present to be procured in London. In consequence of this, the best enamel, which formerly, when smuggled into the kingdom, has been sold as low as from 2s. to 2s. 6d. per lb., and even when the duty has been paid at the Custom-house, at from 3s. to 4s., has progressively advanced to a guinea, and from that to 5s.; and it cannot now be obtained at any price.

ENAMEL-Painting. See PAINTING on Enamel.

ENAMELLING. The art of enamelling is of great antiquity, but of unknown origin. That it was practised by the Egyptians is evident, from the remains that have been observed on the ornamental envelopes of mummies. From them it probably passed to the Greeks, and afterwards to the Romans, who appear to have introduced the art into this country; as various Roman antiquities have been dug up in different parts of Britain, in which enamels have formed portions of the ornaments. That the Britons received the art from their conquerors may be conjectured from the circumstance of enamelled trinkets having been found in British barrows. That the Saxons practised it is certain, from the jewel found at Athelney in Somersetshire, and now preserved at Oxford; which jewel, as appears by the inscription, was made by command of the great Alfred. The gold cup, given by king John to the corporation of Lynn in Norfolk, proves that the art was not lost under the Normans; for the sides of that cup are embellished with various figures, whose garments are partly composed of coloured enamels. The tomb of Edward the Confessor in Westminster Abbey, constructed in the reign of Henry III., was also ornamented with enamels, pieces of which still remain. The beautiful crozier of the celebrated William of Wykeham, of the time of Edward III., may be also adduced as exhibiting some curious specimens of the application of this art: and other examples might be pointed out, of its progressive descent to our own age.

It would seem from the above brief review, that anciently enamels were principally applied to the purposes of ornament; but since the invention of clocks and watches, their usefulness has been proportionally increased. For clock and watch dials there is probably no substance that could be substituted, that can equal enamel in permanence and beauty: in several respects, it possesses advantages even over the rich metals of silver and gold. Within the last 30 or 40 years, an *imitative enamel* has been used, and, through the scarcity of real enamel, is now in much demand for clock plates; but it is by no means comparable with its prototype: for, being chiefly composed of flake white, ground up with spirits of turpentine, and afterwards mixed with copal varnish, it will neither assume an equal brilliancy in colour, nor continue unchanged in different climates; on the contrary, the action of the air occasions it

to become dingy and yellow. In fact, imitative enamelling is nothing more than a branch of the art of *japanning*; which see.

The processes of enamelling have never been accurately described. The jealousies that exist in all arts in which any thing like a scientific knowledge is wanting, operate to seclusion. The practitioner conceals his information from motives of profit, and the amateur seldom acquires an insight sufficiently minute to enable him to unfold the modes of operation. Whatever may be the defects of the present attempt, it will be found to contain a better account of the practical branches of the art than has before appeared.

Enamels are commonly laid upon a metal ground, yet they have been sometimes used in substance, for dishes, flower-pots, ornamental vessels, figures, vases, &c. In these cases, the enamel is run into moulds immediately from the pots in which it has been melted. The metals employed to enamel on are gold, silver, and copper. Of the other metals, some are too fusible to endure the action of the fire, and the remainder, as platina, &c. are, to use the language of the art, too *strong*, for the enamel: that is, the adhesion between the two substances is not powerful enough to keep them together, the enamel cracking as it grows cold, and flying off the metal in flakes. It appears, therefore, that a certain, however slight, degree of oxydation is necessary to make the enamel and the metal unite with sufficient firmness. Gold is unquestionably the best substance to enamel on, its richness of colour showing a beautiful tinge through the enamel: yet the metal generally used, except for watch-cases, and valuable articles of jewellery, is copper; and that on account of its superior cheapness. Both the gold and the copper should be of the finer kinds, the others being too refractory to agree properly with the enamel.

By the custom of the trade, rather than from any principle of utility, enamelling is now divided into two branches, *viz.* dial-plate enamelling, and transparent enamelling. The former includes the manufacture of clock and watch plates, with fluxed plates for enamel painting, the latter comprehends the enamelling of watch cases, broaches, pins, and other bijoux: of late years the making of these lesser articles has gradually grown into great disuse in this country.

*Dial-Plate Enamelling*, consists of the two divisions of hard-enamelling, and soft, or glass enamelling; in the first branch, the Venetian enamels only are employed, in the last, the English or glass enamels. The practice of hard-enamelling requires more skill, time, and labour than the others, and is consequently esteemed the most. In preparing the metals to be enamelled on, whether of gold, silver, or copper, the process is similar; one description will therefore suffice for the whole:—and first of the making of watch dials.

The copper being evenly flatted in long slips (which is done at the flating mills between steel rollers) and to a proper thickness, pieces are cut off for use according to the size wanted. They are then annealed in a clear fire, in order to make them sufficiently pliable to take the required forms which is given to them by means of dies. The dies are small circular plates of brass evenly turned, varying in thickness, perhaps, from the sixteenth of an inch to an eighth, or more, according to their diameter. Some of them are flat, others are hollowed out for the purpose of giving a slight curve to the *copper*, as the metal to be enamelled on is technically termed when prepared for use: the edges of the dies are turned off in an oblique direction, and in the centre is a small hole, rather larger than that which is wanted in the dial-plate. A complete set of dies varies in size from about three-fourths of an inch to two inches and a half, the gradations being very small, perhaps

## ENAMELLING.

not more than the thirty-second part of an inch between each.

The copper being cut with a pair of scissars nearly to the size required and properly annealed, is next placed on the die best adapted for the purpose, and the eye, or centre hole, is made. This is effected by first forcing up the copper into the hole of the die with a small round-headed punch; by this means a small concave bulge is formed, the upper side of which is then filed through with a smooth grained file; it is then again placed on the die, and pressed gradually open till it nearly fills the hole with an oval burnisher; it is afterwards pressed tighter into the hole with a round broach, the burr being occasionally taken off by the file, and care employed to prevent the eye from cracking. The punch, burnisher, and round pin, are all of steel; the two latter taper in regular gradation towards the handles.

When the eye is completed, the edge of the copper is cut round, so as to leave a small part, probably about the thirtieth of an inch, projecting beyond the die. The projecting part is then turned up, or burnished, against the edge of the die, the copper being first laid smooth and flat by the burnisher. The turned-up edge of the copper is afterwards filed evenly round, and reduced to the proper height, according to the thickness of the brass-edge, or rim, to which it is to be fixed when in the watch. The inside burr is then scraped off with a graver, and still further cleared away by means of a scratch-brush: this latter tool is composed of small brags or steel wire tied together in a round bundle, about the size of the little finger. The purpose for which the eye of the copper is formed, and the edge turned up, is to retain the enamel in its proper place, so that the plate may be finished both square and neat.

According to the kind of watch to which the dial is to be applied, the copper, if for a seconds watch, must be kept almost flat; or if for a watch where a greater space is wanting beneath, to give more scope for the wheels, must be raised from the edge to the centre in a regular and exact manner. To effect this a small circular block or setting die is used, made of box or other hard wood turned out to the necessary degree of concavity, and having a hole in the middle to receive the eye of the copper when placed within the hollow of the block. The copper is then gradually set up to the convexity or height required by rubbing it gently yet firmly with a bent, or setting spatula, formed of a thin slip of steel, about five inches long, properly fixed. It is now ready to have the feet foldered on, by which it is to be pinned down to the brass edge or frame of the watch; and the places for the feet being marked on the back of the copper, through the holes drilled for the purpose in the edge or frame, the feet are prepared for foldering.

The feet are always of wire of the same kind of metal as that to be enamelled on, and the wire is drawn into different thicknesses, proportioned to the size of the intended dial-plate; thus varying perhaps from the tenth to the sixteenth of an inch. In the more common kinds of enamelling, the feet are generally cut off from silvered wire, that is, copper wire plated with silver; the silver itself forming the folder when the feet and copper are exposed to the united action of the lamp and blow-pipe. In the best kind of work plain copper wire is used, and the feet are fastened to the copper by means of speltre, or of silver folder. When sufficient care is exercised, either of these modes is equally appropriate, but the feet foldered on with speltre take the firmest hold; those with the silvered wire the slightest. The feet are evenly filed, either to a flat face, or an angular one, according to the description of copper for which they are

wanted; and are cut off the wire into proper lengths by a pair of cutting-pliers or nippers. In order to make the feet remain in their places, and facilitate the foldering, the end of each foot, before putting it on the copper (which is done by means of a pair of corn-tongs or tweezers), is dipped into a slight wash of borax and water, through which it adheres with sufficient force to admit of its being exposed to the power of the blow-pipe. The lamp in common use contains from a pint to a quart of oil, and has a cylindrical spout projecting about three inches, and being an inch or more in diameter. This space is filled with cotton, which being lighted, a good strong flame is produced. The copper is carefully placed upon a piece of solid charcoal, long enough to be held in the hand, and the flame being then propelled by the blow-pipe against the folder, or silvered wire, as the case may be, the feet are firmly united to the copper. In this operation, attention must be given to the exact degree of heat required to fuse the folder, for should it be too powerful, the copper itself will melt at the same instant: care must be taken also that all the feet keep in their due places, otherwise the copper will not fit properly, and the feet must either be cut off, and new ones foldered on, or much trouble will be found in drawing the holes of the brass-edges or frames, to get the coppers into their proper central situations.

The copper being thus far advanced is thrown into the pickling-pan, in order to free it from the scale or oxydable covering acquired from the heat. The pickle is either oil of vitriol, sufficiently neutralized for the purpose by water, or else a solution of the best double aquafortis. When the scale is enough softened to admit of its being removed by a soft brush, used with water and a little white sand, the copper is taken out of the pickle, and all the impurities being washed away, it is dried by means of heat, or else with a soft cloth. In this state, the copper will generally require to be again put into a proper shape, by means of the brass die, and setting block, as it is scarcely possible but that some irregularities will be produced through the operations last described. It is also hardened in a slight degree by rubbing the under side with the setting spatula, and the surface with the scratch-brush. When this is done, the copper is completed, and fit to be enamelled on. It is to be remarked, that when many coppers are prepared at once, much time is saved by turning off the edges by means of the lathe and arbour, instead of by filing them even in the manner detailed above.

The above are the methods by which the common coppers are prepared; it is now requisite to describe what are called *French edges*, from their having been first made in France. These are of two kinds, the solid French edge and the laid-down French edge. To make the former, a piece of copper is taken, either about a sixteenth or a twelfth of an inch thick, according to the diameter of the intended plate, and a hole being drilled in the centre, the copper is placed upon an arbour, and fixed tightly by means of a small cone and screw-nut fitted to the maundrel. The arbour being then fixed upon a lathe, the edge of the copper is next turned off in an oblique direction, inclining inwards, with a graver, and the copper is then reduced to the proper thickness for enamelling from the edge to the centre, by means of a scoper and other tools; thus leaving the edge solid, and taking care also that a sufficient substance is left unreduced round the cone, to form the outer circle of the eye. The laid-down French edge is made by preparing a copper in the common way from a thin slip, the edge being left rather higher than usual, and then fixing it upon the arbour, when the edge of the copper being first turned perfectly even with a

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graver, is next forcibly bent inwards by a small triangular tool, (perhaps formed from the end of a three-square file worn smooth,) and afterwards squared and finished by the graver and scratch-brush. It is in general necessary to reverse the coppers on the arbour, and turn a small portion of the under side away, both of the solid and laid-down kinds, in order to make the edge of a due sharpness. The coppers are lastly set up, and the feet soldered on, as before described. French edges are mostly used for watches of a particular kind, where room is wanting, and the dials are fixed upon the frames without a brass-edge.

When a dial is made for a seconds' watch, or for one requiring still more circles than two, the additional eye, or eyes, is made by marking the centres accurately with a point on the under side of the copper, and then bulging the copper upwards with a small punch from each centre, by striking it gently with a small hammer into a piece of lead, about three times the thickness of a die; the lead forms a sufficient resistance to prevent the eye from cracking, and is yet soft enough to admit of the copper being bulged up evenly. The small eyes are afterwards evened with the file, and opened with a small needle or round-pin to the required sizes. Some trivial variations in the mode of making the seconds' holes, &c. occasionally occur.

The coppers being thus prepared, the next process is that of *enamelling*, properly so called. Where the operations of *hard enamelling*, and *glass enamelling*, are dissimilar, the difference will be described in proceeding, but to a certain extent they are the same.

The enamel, as it comes from the makers, is generally in small cakes from four to five or six inches in diameter. In preparing it for use, a small hammer is used, having one end flat, and the other of the shape commonly employed to rivet with. With this the enamel is broken into thin pieces or flakes, by striking the edge of the cake smartly as it rests upon the fore finger of the left-hand. The pieces are then put into an agate mortar, and with a pestle of the same kind are finely pulverized, the splinters being prevented from flying about, by keeping the enamel covered with pure water all the time the process of *grinding* is going on. The point at which the trituration should be discontinued, can only be ascertained from experience, as the different kinds of enamel, and the different modes of its application, require the *ground* enamel to be either more or less fine. In general it may be stated, that the *backing* should be much finer than the *first coat*; the *second coat* of an intermediate fineness; the hard enamels considerably finer than the glass, and the flux still finer than those, as the fire operates with less effect upon the flux than upon either of the former substances. In grinding, great care must be taken to keep the enamel free from dirt, and the light slue which arises must be washed away three, four, or more times, as may be necessary in the course of the operation, till the water comes off quite clear. A small tea-pot is commonly used to pour the water from, and when the enamel is ground sufficiently, the produce is emptied into some other small cup for use, the surface being kept just covered with water.

The manner in which the grinding is performed, is by placing the mortar upon the work-board, on a coarse piece of flannel or linen, twice or thrice doubled, and wetted to prevent its slipping. The handle of the pestle is then grasped firmly about the middle with one hand, and the palm of the other being placed upon the top, the operator inclines the upper part of his body over the mortar, and crushes the enamel by pressing forcibly with his breast upon that hand which covers the pestle. This motion is repeated in quick succession, till all the larger pieces are reduced into

coarse and uneven grains; which grains are afterwards ground to the requisite equality and fineness, by holding the mortar firmly down with one hand, and with the other giving a circular direction to the pestle, using at the same time as much strength as can be conveniently exerted.

In enamelling watch dials, many coppers are usually prepared to go on with at once; that method possessing the three-fold advantage of saving time, materials, and labour. When the enamel is ground, therefore, the coppers having been first cleaned by the pickle, and carefully brushed out with water, are spread, face downwards, over a soft half-worn cloth, or smooth napkin, and a thin layer of hard enamel, called, in its ground state, the *backing*, is spread over the under sides with the end of a quill, properly cut, or with a small bone spoon. The coppers are then slightly pressed on by another soft cloth or napkin, which, by imbibing some portion of the water, renders the enamel sufficiently dry to be smoothly and evenly spread with the rounded side of a steel spatula. The water is then again dried out by the napkin, and a yet further evenness produced by going over the enamel as before, with the spatula, and these operations are repeated, till the back becomes completely smooth, and the enamel is of an equal thickness all over. It must be observed, that the water should not be *entirely* absorbed, as in that case the enamel would fall off, in powder, before the subsequent operations are completed. When the enamel is properly spread, the loose particles are carefully cleared away from the edge and eye of the coppers; from the former by the spatula, from the latter by twirling round it the pointed end of a quill, and the process of *laying the bottoms* is thus finished. Some slight variations to the above method are in use among different artists, but the difference is scarcely important enough to require description. In some instances the enamel is laid on with the spatula itself, and the coppers, instead of being held between the fingers, are placed upon the round pin, by means of the centre holes, till the backs are duly spread: in both modes due care must be taken that the coppers are not bent out of their proper forms.

The next operation is to lay the *first coats*; that is, to spread a layer of *glass* enamel over the upper sides of the coppers. In doing this, the surface is first brushed slightly over with a small camel-hair brush, or a hare's foot, to remove any dirt or extraneous particles of enamel, as the mixture of any hard enamel with the glass would infallibly spoil the work. The glass is then spread upon the coppers in a layer, the thickness of which is commonly the same as the height of the edge and eye. The water is afterwards slightly absorbed with a clean napkin smoothly folded, and the enamel spread by a thin, flat spatula, till all unevenness is removed, and the surface lies regularly from edge to centre. The edge being then gently tapped twice, or thrice at different places with the spatula, the water rises towards the top, and is again dried off by the napkin, when the enamel is once more made smooth by the spatula, and the water being wholly taken up by the napkin, or as nearly so as can be effected, without disturbing the enamel, the *first coats* are placed upon rings for *firing*.

The rings used in enamelling are generally made of a mixture of pipe-maker's clay and Stourbridge clay, rolled up into the form of cylinders, and turned in a lathe by means of a cylindrical piece of wood forced through the centre of the mass when wet. Each ring is about a quarter of an inch in thickness, and the same in depth; the upper side is prepared for use by rendering it slightly concave, which is done by rubbing it carefully upon a half globe of lead sprinkled over with fine silver sand: the under side is nearly flat. Through the concavity thus given to the rings,

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the edge of the copper or dial-plate only is suffered to touch, by which means the enamel on the back remains undisturbed, and the edges are prevented from sticking by rubbing over the surfaces of the rings with soft chalk or whiting.

The first coats having been placed carefully upon the rings, are next put into a shallow tin vessel, called a tin cover, which is either made square or round, according to the fancy of the artificer, and is commonly about three quarters of an inch in depth. All the moisture is then slowly evaporated from the enamel, by placing the cover upon a German stove, or in some other convenient situation near a fire, where the evaporation can be properly regulated: for, should the water be dried off too quickly, the work would be in danger of spoiling from *blebs* or *blisfers*. These are very small air-bubbles, which, by rising to the surface of the dial-plates, destroy their smoothness and beauty. They appear to be occasioned, partly by want of due care in laying on the enamel, and partly by the confinement of the air which the water contained, and which, in the process of firing, becomes rarefied; throwing off, by its expansion, a portion of the surrounding enamel, yet not entirely escaping without a very vivid heat, and even then resolving into black or green specks, so coloured through the oxydation of the copper.

The firing is executed beneath a muffle, placed in a small furnace ignited with coke and charcoal. (See *MUFFLE* and *FURNACE Enamellers*.) The furnace being drawn up to a sufficient heat by means of a register, the first coats are taken separately from the tin covers, and placed upon thin planches of clay, or iron, chalked over, and gradually introduced beneath the muffle; where, in a very short time, the enamel melts, or technically *runs*; and becoming properly consolidated, the first coat is complete. Great attention is requisite in this operation, to prevent the enamel from being over-fired; as in that case, the glass would lose some portion of its opacity, and other defects also be produced, to the detriment of the work. The planches are placed towards the further extremity of the muffle, by means of a pair of spring tongs; and as soon as the fusion is seen to take place, are turned carefully round, in order that every part should be equally fired. The planches are generally made circular, and slightly concave, for the convenience of moving the work without danger of shaking off the enamel before it becomes fixed by the heat.

As all solids, when reduced to a granulated state, occupy a greater space than before, *et vice versa*, it will be found that a very considerable depression has been produced in the enamel of the first coats by the act of fusion; and that the edge and eye are now much above the surface. This deficiency in substance it is the office of the *second coats* to supply. When the work is cooled, therefore, the scale is wholly removed from the edges and eyes by means of a fine-grained Lancashire file, or a smooth grey-stone; and being then washed and dried, each plate is put upon a small round wax-block, of sufficient bulk to be held in the hand, and about four or five inches high. The feet are then either pressed firmly into the wax which covers one end of the block, or the plate is otherwise fixed by means of three small cones of wax placed triangular-wise upon the block; care being taken not to strain the enamel by too weighty a pressure. A second layer of ground enamel is then gently spread with a quill, and prepared for firing by the napkin and spatula as before; after which the second coats are placed upon the rings, and the moisture being evaporated in the tin-cover, (one edge of which, both in this and in

the preceding operation, should be left a little open to give issue to the steam,) they are ready for a second fire.

The second firing requires an equally cautious management as the former one. The plates must not be over-fired, nor must the heat be suffered to melt the enamel too rapidly; but a kind of rotatory motion, called *coddling*, must be given to the work, by holding the loaded planch lightly with the tongs, and gently drawing the edge of it towards the mouth of the muffle, and then returning it to its former place, till the fusion be complete; a proper knowledge of which can be gained only from practice. The work is now in a fit state for polishing.

*Polishing*, in this art, has a twofold signification: it not only means to render bright, according to the common acceptance of the term; but also to make even, without any reference to glossyness. The enamel has a natural brightness of surface acquired from the fire; and when this is removed, it is only necessary again to expose it to a due heat, to cause it to reassume its former character. Yet as this brightness exists independent of evenness, and as evenness is essential to the perfection of enamelling, it is requisite, in most cases, to produce that quality by the methods next to be described.

The materials used in polishing glass plates are grey-stones, rag-stones, sometimes called burrs, fine ground silver sand, and water. The grey-stones ought to be of a fine grain and even texture, without knots, which would be very detrimental by making deep scratches in the enamel, instead of wearing it away evenly. The plates are taken separately, and the thin edges are first worn off by one of the finer grey-stones, till they become smooth and equal; after which the eyes are rubbed down, till the centre of each plate is even and square. Either the grey-stone or the rag-stone is next employed, according to the nature of the work, to wear away all the irregularities that may exist on the surface of the enamel; the rag-stones being only used for the more common kinds of dials. This is done in different ways; *viz.* first, either by holding the plate upon the fore and middle finger of one hand, and giving it a sort of circular motion by means of the thumb, whilst with the other hand the polishing-stone is rubbed with a forward and backward stroke over every part of the surface; secondly, by holding the polishing-stone on the work-board with one hand, and with the other rubbing upon it the face of the enamel; or, thirdly, by fixing the plate upon a cork, either by means of the feet, or with a piece of wet flannel, and with the fingers giving it a kind of rotatory motion, whilst the polishing-stone is rubbed over it in a similar manner. The ground silver sand is used to give sharpness to the polishing-stones, and wear away the enamel with greater celerity than would be otherwise acquired; and the act of polishing is continued till all the gloss is ground off the surface. In this operation great care must be taken that the pressure be not too powerful, as the plates will then crack in the fire, and can never, or very rarely, be properly mended.

When the enamel is sufficiently polished, which is easily known by the criterion of all the gloss being removed, the plates must be clean washed, and the specks of dirt, &c. picked out with a sharp graver. They are then well rubbed over with some fine ground glass, either by means of a cloth, a glass mull, or perhaps a small bit of fir-wood cut smooth, in order to remove the stains that may be left by the polishing-stones; and the clean water being suffered to run over them, they are wiped dry, and again placed upon the rings for firing.

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The degree of heat necessary for polished plates is determined by the finer or coarser modes in which they were prepared; as the fusion is much facilitated by the enamel being free from scratches. When the surface is properly run, that is, when it becomes perfectly smooth, even, and bright, the plate is completed; and when cold, is fit for painting on. See *PAINTING of Clock and Watch Dial-Plates*.

The above description regards more particularly the best kinds of work; but for the more common work there are two other modes of enamelling practised, which it will be requisite briefly to explain. The plates made in these ways are called *run-down plates*, and *run-down second coats*.

Run-down plates are those which are made by laying the enamel upon the coppers in sufficient quantity to form plates of the required thickness, without putting on a second coat. Both labour and fire are thus saved; but that neatness, regularity, and squareness, which are acquired by the first method, are rarely obtainable in this: and indeed flat plates can hardly be managed at all in this mode. Run-down plates require more coddling than any other; and a longer continuance of vivid heat is necessary to make the glass flow to a proper evenness of surface: the plates being wholly completed with one fire, and without polishing. It is obvious that the most common work only can be thus manufactured; for that of the next superior description, the run-down *one coats*, are polished off with the rag-stone, and undergo a second firing. The run-down second coats are those which are reduced to a surface comparatively even by the second fire, and are then painted on without being polished off.

In enamelling *hard-plates* for watches, the coppers and the first coats are prepared in the manner above described; excepting perhaps that the layer of glass is rather thinner than in glass-work only. The hard enamel, which is generally most valued as it approaches to a rich cream colour, is broken down, and ground in the same way as the glass, if a small quantity alone be wanted; but if otherwise, it is first broken from the cake with the hammer, and then pounded in a steel mortar, till reduced into coarse grains. These grains are then exposed to the action of a magnet, in order that all the particles of steel that have been broken off the mortar in the act of pounding may be taken away, as they would infallibly spoil the work, by rising in black specks to the surface of the enamel, when in the fire. As an additional precaution, also, it is necessary to put the granulated enamel into a small basin, and pouring upon it a strong solution of oil of vitriol, or aquafortis, to suffer it to stand for some hours, that the steel particles, &c. may be wholly dissolved; after which, the enamel must be very carefully washed, till the water comes off pure and tasteless: for should any of the acid remain, the work would certainly blister. The enamel is then ground to the necessary fineness in an agate mortar, and afterwards spread over the first coat with a quill, in small quantities, and as evenly as it can be laid, that it may require the use of the spatula as little as possible. The water is then partly absorbed by a very fine and clean napkin, and the enamel smoothly spread and closely compressed with the spatula; after which, more water is absorbed, and the spreading is continued till the surface lies true and equal. The plate is then put upon a ring, and properly fired; and is afterwards polished by placing it upon a cork, (the top edge being first taken off with a fine grey-stone,) and wearing away the surface, first, by a very fine-grained Lancashire file, or smooth piece of steel, and silver sand, ground to an almost im-

palpable powder; secondly, by a fine blue-stone and sand; and thirdly, by the blue-stone alone. With the latter a sort of half-polish should be given to the enamel; and the nigher that polish approaches to complete glossyness, the better; as the plate will then be finished in the third fire with a less degree of heat than would be otherwise wanted: In this process, much caution is required to prevent scratches, which cannot be *run up* by the fire without giving the enamel a greater heat than it will well bear. When the polishing is completed, the plate is carefully cleaned with ground enamel; and should there be any specks, they must be picked out with a small and sharp diamond, and the hollows very dextrously filled up with enamel from a quill-point, that they may neither rise above or sink below the common surface, when the plate is again fired: should they actually do so, they must be made smooth with a blue-stone, and the plate must undergo a fourth fire, to render the surface of one uniform texture and glossyness. Hard-enamel dials are always considerably dearer than glass ones, through the greater labour, attention, &c. that are requisite in making them; and the best watches are almost always made up with dials of this kind.

In the polishing off both of glass and hard plates, much address is necessary to prevent a separation between the enamel and the edge of the copper; for if too great a pressure is exercised, or if the grey-stones, which are employed to wear down the copper, are of too rough a grit, the adhesion will be destroyed, and various black indents arise round the edge of the enamel, when the plate is again exposed to the fire. In glass dials, these defects may be sometimes amended; but in hard-enamel dials, scarcely ever.

The operations of *transparent enamelling* are nearly similar to what have been already described in the making of watch dials. As the work is generally of a more minute kind, greater delicacy of handling perhaps is required; and as the enamels are of various colours and descriptions, more cups, vessels, &c. and additional soft cloths or napkins, are wanting to keep them from mixing. Watch cases are commonly enamelled upon gold, as well as most superior articles of the fancy kind; and the surface of the gold is frequently engraved into different figures and compartments, before the enamel is laid on; by which means the work assumes a beautiful variegated appearance through the vitreous coating.

In enamelling the backs and edges of watch-cases, &c. quince-water is frequently used as the medium by which the enamels are laid on; for this possessing a more adhesive and retentive quality than common water, better prevents the enamel from flowing from its proper situations: for where the convexity is considerable, the enamel will of course have a tendency to float towards the lowest part. When enamels of different colours are intended to be employed on the same article, which is frequently the case in ornamental works, small edges or prominent lines are left in the substance of the metal, for the purpose of keeping the enamels separate; and these are polished with the enamel, and reduced with it to a similar equality of surface. Transparent enamels are not unfrequently polished to complete glossyness, without exposing them to an additional fire: in these cases, the work is finished with rotten-stone.

It is sometimes desirable to take off the enamel from a watch-case or trinket, without injuring the metallic part. For this purpose it has been recommended to lay a mixture of common salt, nitre, and alum in powder, upon the enamel requiring to be removed; and afterwards to put it into the furnace: and when the fusion has commenced, to throw

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throw the case, &c. suddenly into water, which causes the enamel to fly off in flakes.

In ornamental transparent work, a very pretty effect is often produced by applying small and very thin pieces of gold or silver, cut or stamped, into different figures, as acorns, oak-leaves, vine-leaves, bunches of grapes, fruits, &c. upon the surface of the first coating of enamel, where they are fixed by the fire; and are afterwards covered over by the second layer, through which they appear with considerable beauty. When any quantity of fancy-works of similar design is wanting, this mode of enamelling is much cheaper to execute than to have the surface of the metal itself engraved into the required forms.

*Clock Dial-Plate Enamelling*, is far more laborious than the other branches, and requires considerable experience to be properly executed, though the methods of operation are soon explained. The copper, being procured from the flattening mills in thin slips, and of an adequate diameter and thickness, is cut to nearly the required size with a pair of strong scissars, a circle having been first struck with the compasses. If in a soft state, it is then cleaned by the pickle, and having been brushed out with sand on a flat board, is washed and dried for planishing; if otherwise it must be well annealed before it is thrown into the pickle, where it must lie till all the scale is enough softened to be removed by the hand-brush, sand, and water.

*Planishing* is a very important part of clock-plate enamelling, and too much care cannot be exerted in the process, as the necessary regularity of surface almost wholly depends upon it. In large plates the action of the fire has a very considerable effect, as it causes an expansion in the metal, which, unless properly guarded against, cannot but operate to the imperfection, and perhaps total spoiling of the work. In flattening also, a sort of twist is not unfrequently given to the copper, during its passage through the rollers, that would assuredly cause the plate to become uneven and out of shape, were it not to be removed by planishing and repeated annealings. Another effect produced by the fire, is occasioning the plate to rise, perhaps irregularly, towards the centre, and this can only be checked by counteracting the action which the heat would otherwise generate in the metal by good planishing. To keep a large plate entirely flat is impossible; or at least no means have as yet been discovered through which that aim can be attained. The best way, therefore, to provide against the irregularities which the fire might cause, is to give to the copper, in the course of planishing, a slight and even rise or curve from the edge to the centre; this can either be effected by the use of large brass dies, or by a machine adapted for the purpose.

The *machine* of which, probably, there is only one in the trade, consists of two principal parts; the one a solid mass of iron, with a concave and polished face, imbedded immovably in a strong oak block, firmly fixed on a foundation of brick-work, and the top edge hooped with a thick iron ring, to prevent splitting; the other, an answering and weighty mass of iron with a convex face, similarly polished, and fixed in an upright frame of timber, but so contrived as to become *moveable* by means of sliding grooves, a rope, a pulley, and a lever, and so placed as to fall directly upon the mass beneath, in a similar way to the monkey of a pile-driving engine. The diameter both of the hammer and the anvil, as the upper and under masses of iron may be called, for the sake of perspicuity, is about thirteen inches; that size being nearly as large as clock dials are ever made or wanted. The convexity of the hammer is exactly fitted to the concavity of the anvil, and may be described, perhaps, as forming a portion of a circle fifty feet in diameter; and the

centres of both are kept true to each other, and consequently to the regularity of curve, by means of large screws and nuts, which adjust the position of the hammer by altering the perpendicularity of the bars of iron that the grooves act upon. The power of this machine saves much labour in planishing, as well as time; yet as it is insufficient wholly to prepare the coppers, and as the charge of erecting one would be very considerable, it will never, perhaps, come into general use.

In planishing with this machine, it is necessary to be provided with various thin circular pieces of lead, evenly flatted, and adapted in size to the diameters of the coppers to be planished. Without these the stroke given by the hammer would have a very imperfect effect; and the impulse given by the weight of its fall would also be continually weakening the foundation and bed of the anvil.

The coppers prepared for planishing by this machine are taken separately, (the eyes having been previously cut out to a proper size by means of an iron punch, an hammer, and a lead block,) and each one is laid upon a lead of a correspondent diameter, and placed upon the anvil in such a manner that all the centres agree. The hammer, which has been hitherto retained at some height by an iron stay fixed in one of the timbers, and moving on a pivot, is then let fall, three or four times in quick succession, it being each time lifted up to the height of three feet or more, by means of the lever. The hammer is then again fastened by the stay, whilst the copper is turned over on the lead, after which the operation is repeated, and the copper is then taken off, and another laid down till the whole are gone through. The weight of the hammer, and the impetus acquired by its descent, remove most of the unevennesses in the coppers, yet cannot entirely remedy them: a strong and unequal spring will still be felt, and the metal being now rendered hard by the action of the hammer, annealing must again be resorted to, and the coppers must be pickled and cleaned as before. The machine is then used a second time in a similar way; and afterwards a third, a fourth, a fifth, and even a sixth and seventh time, according to the diameters of the coppers, or to the refractoriness of the metals, due care being taken properly to anneal and pickle them between every operation.

The coppers will now be found of a regular shape, and the spring in the metal tolerably uniform; it is essential, however, to the perfection of the plate, that the spring should be *entirely* uniform from edge to centre, otherwise the plate would warp and cockle in the fire. A kind of intermediate process must therefore be carried on between the taking the coppers from the machine, and before repeating the annealings. This is performed by means of a circular brass die, about a quarter of an inch in thickness, and from fifteen to eighteen inches in diameter, screwed firmly down to a strong oaken block, having three stout legs, placed triangular-wise, and of a sufficient height to use conveniently when the artist is in a standing posture. The die should have the same degree of curve as the machine, otherwise the effect produced by each would occasion a sort of reciprocal counteraction. The coppers, having passed through the machine, are placed in succession upon the die, and a wooden box-hammer (somewhat resembling that used by gold-beaters) with two faces, the one a circle about three inches over, the other cut away on the front edges, so as to leave only a portion about an inch or an inch and a quarter in breadth remaining in the middle, is then taken, and the copper is both rubbed and struck with it till the metal becomes too hard for any further impression to be made, and requires annealing. The circular end is used to strike the copper

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copper with, which is done by short, quick beats of the hammer, the artist working from centre to edge, and communicating the necessary motion and direction to the coppers by means of the fingers of one hand, so extended over the work as to give the requisite command in guiding it: the other end is employed in rubbing the coppers strongly with a backward and forward action, under which they are moved upon the die by the fingers as before. Where the machine is not used, the planishing must then be entirely performed in the way just described, and great care must be taken, that in the rubbing, the coppers be not beat, which would occasion both additional labour, and further annealing. No positive direction can be given as to the number of times that the coppers must be annealed in the course of the planishing; as a general rule, it may be said that the larger the size, the more frequently must the annealings be repeated. For plates of from three to four inches, twice or thrice is commonly enough; from five to eight inches, about four or five times are requisite; for larger sizes, the annealings must be continued till the spring or action in the metal becomes uniform, as already mentioned. This is best determined by the regularity with which the copper will flap or jerk into the curve given by planishing when turned either side uppermost upon the die. When the planishing is completed, the coppers are cut exactly to the sizes required, and having been pickled and cleaned, they are then ready to be enamelled on. After the last annealing, it is best to planish but slightly, that the coppers may be left in a state of comparative softness.

For time-pieces, table clocks, and some others, *round* plates are commonly used, and in these cases it is necessary to have moveable brass dies formed into the curves required. Round plates are those which have a considerable rise in the centre, made by a pretty quick forcing up of the copper into a sort of shoulder about where the circles of the hours come, and afterwards continuing the rise more gradually. The bent spatula and the scratch brush are chiefly employed to set the coppers into these curves, and where the rise is very quick from the edge, the copper is sometimes turned up as in small dials, that the enamel may be the better retained in its place.

The quantity of enamel wanting for clock dials renders the grinding it a very laborious and tedious operation; especially as the hard kind only can be used with complete certainty. It is true that plates of from ten to twelve inches diameter have been made with glass enamel, where particular attention has been given to the *annealing up*, and to the *cooling down*, (phrases that will be presently explained,) and where the backing has been of a quality perfectly agreeing with the nature of the glass. Of the experiments made in this way, however, the success has not always been proportionate to the loss, and the few enamellers who have clock-furnaces cannot always be induced to repeat them.

The enamel for clock dials is broken down in a steel mortar, and afterwards cleaned and ground in an agate mortar, in a similar way to that prepared for watch plates. Sometimes, where the enamel is of a good quality, the *washings* are made use of for backing, and no bad consequence results, but this requires considerable care in the laying on as well as in properly drying, in order to prevent the surface of the back from rising in blisters, either entirely or partially. Washings is the name given to the almost impalpable powder which arises in grinding, and floats in the water, intermixed with the dust and minute hairs which are sure to fall into the mortar, and which renders it necessary that the enamel should be several times washed during the process by pouring off the buoyant matter from time to time, and introducing

fresh water, from the tea-pot. Pure spring water ought always to be used, and a large basin provided for the reception of the washings.

In the best and largest kinds of work, the washings ought never to be used, as their great propensity to blister can hardly be counteracted; and when the blistering is considerable, the plates will assuredly *cockle*, or get out of shape. The peculiar fineness of the washings, also, occasions it to be very difficult to lay on as backing in an even manner. Where the enamel in substance only is used, the success of the work is rendered more certain; the additional expence therefore is fully balanced by the greater security.

The general way of putting on the enamel is to lay the copper upon a cloth, twice doubled, and placed upon a die or piece of board, for the convenience of turning. The backing is then spread carefully over it by means of a small ivory or bone spoon, and when the whole surface is covered, the water is partially dried off by another cloth, and the enamel laid even by a large spatula, (see *SPATULA*,) finely polished. These operations are repeated till the back surface is sufficiently evened and dry; when the copper is turned, and the first coat laid on and evened in a similar manner. The work is then placed upon a planch for firing, and is next put into the annealing places in the upper part of the furnace, (see *FURNACE for Clock-Dials*,) where the humidity is gradually evaporated as the fire draws up. The planches are from a quarter of an inch to three quarters in thickness, in proportion to the size, and are either made of fine free-stone, or of a composition of Stourbridge clay, pipe clay, and *old stuff*, as the broken muffles, planches, &c. are called, pounded together in an iron mortar, and passed through a coarse sieve. The face of each planch is either flat or rubbed into a similar curve to that given to the coppers, and before the work is put on to it, a slight covering of whiting, dried, is sifted over it, through a small brass-wired sieve: this is done to prevent the enamel from sticking to the planch when in the act of fusion.

The muffle is *got up* or rendered hot with sea-coal, and when sufficiently vivid, which is known by its near approach to a white heat, the first coats are taken from the annealing holes by means of iron prongs, which are slid beneath the planches by a steady and careful motion, lest the enamel should be shook whilst in powder; to prevent this, also, a farther provision is frequently made by means of *irons*, as they are called in the business, which are placed below the planches, and having a round form, and a convex bottom, are extremely useful in moving the work, by admitting the prongs to be readily passed below them. The irons are adapted to the size of the planches, and are formed out of thin iron plates, and are cut into a circular shape; some portions of the metal, to render the irons less weighty, being wholly removed from between the rim and the centre, which from this circumstance appear to be connected by cross bars.

When the first coats are properly fired, which can only be determined from practice, they are replaced in the annealing holes, and there left for some hours to cool down, all the fire having been first raked out from the furnace. The operation of cooling down must be effected in a very gradual manner, for were it done too quickly, the plates would crack in different places, through the action of the metal upon the enamel. The particular cause of this cracking seems to arise from the surface of the enamel being too suddenly fixed by the cold air, to admit of that gradual adjustment to the contraction of the metal, which the latter, by retaining the heat longer than the enamel, renders necessary. On a similar principle, the annealing up of the second coats must be equally progressive; for should they be too suddenly

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suddenly put into the fire, the metal, by expanding with the heat before the fusion of the enamel has commenced, would cause the enamel to fly through its brittleness, and the surface would be thereby streaked with cracks.

The enamel for second coats, as in watch plates, must be ground finer than for first coats, yet not so fine as for backing. It is laid on with a spoon, and reduced to a smooth and equal surface by the spatula, in the same manner as above described; and the plate being enamelled with the requisite attention, is fired a second time, and gradually cooled down as before. The next operation is polishing.

Clock plates are polished by a somewhat different process than watch dials. When perfectly cold they are taken off the planches, and either carefully fixed upon a bed of wet sand, so that not any hollow or vacancy is left below the plate, or imbedded in a similar way with sand upon wet flannel, twice or thrice doubled. When thus prepared, the surface is gradually worn even by means of fine silver sand, passed through a sieve, that the coarser particles may be prevented from scratching the enamel, and polishing-stones formed of flint pebbles, ground at one end to a regular surface. The sand is used with water, and the operation is performed by giving the polishing-stone a quick circular direction in progressive movements over every part of the plate, till the surface is evenly reduced, which is known by the glossiness being wholly worn off: this occupies from half an hour to an hour, or more, according to the size and previous evenness of the plate. Sometimes the polishing is accelerated by using pieces of lead or iron, as half-pound weights, for instance, in the early stage of the process, and afterwards finishing with the flint; and that not only to give a smooth surface to the enamel, but likewise to remove the general stain or blackness which proceeds from the use of the lead or iron. When the polishing is completed, the plates are well washed and brushed, and afterwards made perfectly clean by some fine enamel being ground over the face of each with a small mull or polishing-stone for about a quarter or half a minute; the operation being repeated twice or thrice, as may be necessary, and the loose enamel being carefully wiped off with a smooth cloth or napkin, after the last cleansing, instead of being washed away: this is done in order that the small pores which are sometimes laid open by polishing into the substance of the plate, may be filled up by the minute particles of enamel that escape the action of the cloth, but would be removed by the water. Whatever specks or blisters may be in the plate, are then opened with the diamond, and the holes neatly stopped with finely-ground enamel from a quill-point, as in watch-plates; the *stoppings up* being suffered to lie rather higher than the surface, to admit of the reduction in bulk occasioned by the fusion. The plates are now again put into the annealing places upon the planches; and the furnace being properly heated, are fired for the third and last time, before painting. In this latter firing, great care should be taken that the enamel be not over-fired, which would occasion a freckled appearance in the plate, when held against the light; and if the work is drawn out from the muffle after the fusion has commenced, and again returned to complete it, the air will be found to have given additional richness to the glossiness of the surface. The precise time required for firing polished plates can only be known from practice; those on which the finest polishing-sand was used, and, of course, where the scratches are less deep, wanting less heat than when the sand has been employed in a rougher state. After firing, the finished plates are returned to the annealing-holes, and gradually cooled down for painting on. See *PAINTING of Clock and Watch Plates*.

In the making of *fluxed plates* for enamel-paintings, similar methods of planishing are practised to those already detailed; and similar or even increased care must be taken in destroying or regulating the spring of the copper. Fluxed plates are commonly either square or oval: in the square ones, about an eighth of an inch, or somewhat more, should be cut off each angle of the copper, previous to enamelling, to prevent the danger of breaking them. In preparing them for the flux, every thing is conducted in the same way as for clock-dials, till they are polished off, when, instead of firing them in their polished state, the flux is laid on as a third coat. In grinding the flux, very particular attention must be given to keep it free from dirt; and the grinding must be continued till the flux becomes extremely fine, as it will not otherwise flow to an even surface, when exposed to the fire, without a more intense heat than the substance will well bear. The flux indeed requires a peculiar delicacy of treatment, and the firing of the fluxed plates must be managed with great caution and nicety. The heat which they require in fusion is much stronger than that for enamels only; but the exact point of time for withdrawing them from the furnace must be dexterously seized, lest the flux should fall into freckles. It is not customary to polish off the flux, as by so doing it would be deprived of some portion of its brilliant richness; yet that perhaps would be in some measure compensated for, by the superior evenness that would be attained. Fluxed plates must be cooled down with great care, as the brittleness of the upper coating renders them more liable to crack when too suddenly made cool. In fluxing, hard enamel must always be used; as the flux will not agree with glass enamel, but cracks in circles as it grows cold. See *FLUX*.

The greater ductility of gold, and its superior mellowness of colour, render it by far the best metal that could be employed for the basis of fluxed plates; though, on account of the expence, it is seldom used. For naked figures, portraits, or other subjects, where much flesh is exhibited, gold plates ought to be exclusively employed, as their rich hue would save considerable labour in the painting.

Till the present age, fluxed plates were seldom made of a larger size than four or five inches; but since the art of enamel-painting has been carried to such great perfection by Mr. Bone, enamel-painter to the king and the prince of Wales, they have been progressively increased in extent for his use, and are now made of every size up to twelve and fourteen inches. The largest ever completed measures eighteen inches by sixteen and a half; and Mr. Bone is now employed in painting it from Titian's famous picture of Bacchus and Ariadne, in the collection of lord Kinaird. See *PAINTING on Enamel*.

In chusing enamels for use, great experience is necessary: indeed the most expert practitioner may be deceived, unless he make the requisite trials by aid of the furnace. Some enamels can only be employed alone; others may be used for the upper coats, but require a stronger kind for the backs; and some can be used only for backing. Should a new sort be proffered for use, experiment alone is the criterion by which its qualities can be determined. In a similar manner, some fluxes will only agree with particular enamels; others must be used separately; and others again must be mixed in grinding, before they can be employed with certainty.

In every branch of enamelling, it is essential that the copper, or other metal employed to enamel on, should be of a proper thickness. Should the metal be too thick, the plates will always crack, either in their second coats, or in their polished state; and should it be too thin, they would

be extremely likely to warp from the too powerful action of the enamel. The due medium can only be ascertained by practice; for even the different kinds of enamel will require a difference in the thickness of the metal.

The proper management of the fire; and the mode by which the muffle is heated, will be explained under the words FURNACE and MUFFLE; it need only be stated here, that the time necessary to get up a clock furnace varies from about an hour and a half to two and three hours, or more, according to the intensity of the draught, the method of stoking, and the quality of the fuel. The work is turned in the muffle by means of spring tongs, so that each part may have a regular and due heat; and it is returned into the annealing places with the prongs. Should many plates be fired at one time, the labour will be found to be very severe, and the heat too powerful; as it carries a flux of blood to the head, and occasions languor and oppression throughout the whole frame.

ENAMELLING Flux. See FLUX.

ENAMELLING Furnace. See FURNACE.

ENAMELLING, Imitative. See JAPANING.

ENAMELLING Muffle. See MUFFLE.

ENAMELLING Spatula. See SPATULA.

ENARA, in Geography, the chief lake of Lapland, in the northern extremity, about 70 British miles in length by 30 at its greatest breadth.

ENAREA, a province of Abyssinia, conquered by the troops of the Negus, at the beginning of the 17th century, situated at the S.W. extremity of the empire.

ENARGEA, in Botany, from *εναργεια*, conspicuous, or distinguished, alluding doubtless to the striking and elegant appearance of the plant, so little to be expected in the dreary country about the Straits of Magellan, of which it is a native. Banks in Gært. v. 1. 283. t. 59. f. 3. Schreb. 232. Willd. Sp. Pl. v. 2. 230. Mart. Mill. Dict. v. 2. (Callixine; Juff. 41. Lamarck t. 248. f. 2: also, Philesia; Juff. 41. Lamarck t. 248. f. 3. Willd. Sp. Pl. v. 2. 231.) Class and order, *Hexandria Monogynia*. Nat. Ord. *Sarmentacea*, Linn. *Asparagi*, Juff.

Gen. Ch. Cal. none. Cor. Petals six, erect, elliptic-oblong, acute, inferior; three of them exterior; three interior, larger. Stam. Filaments six, shorter than the corolla, equal, awl-shaped, dilated at the base, slightly attached to the bottom of each petal; anthers oblong, versatile, incumbent. Pist. Germen superior, globose; style the length of the filaments, erect, swelling, and triangular upwards; stigma in three obtuse lobes. Peric. Berry globose, of three cells. Seeds angular, three or more in each cell.

Ess. Ch. Calyx none. Petals six, erect; three of them internal. Stigma three-lobed. Berry superior, with three cells and many seeds.

1. *E. marginata*. Gært. as above. Willd. Sp. Pl. v. 2. 230. Petals nearly equal. Leaves with many ribs.—Our specimens of this pretty little plant were, some of them, gathered by Commerçon in the Straits of Magellan, and communicated by the celebrated M. de Jussieu; others by Mr. Archibald Menzies in Staten land near Cape Horn, in Feb. 1787, all of them in blossom. Lamarck's figure is a tolerable representation of the whole plant, except the stigma, which he erroneously draws simple and entire. His fruit is copied from Gærtner.—The roots are creeping, and throw out clusters of branched fibres. Stems a span high, erect, branched, angular, destitute of pubescence, as is the whole herb; branches zig-zag, leafy, sheathed at their base. Leaves alternate, nearly sessile, upright, about half an inch or more in length, elliptical, acute, entire, somewhat re-

volute, their edges rough with minute spines; their underside marked with three or five strong prominent ribs; the upper even. Flowers terminal, solitary, drooping, on short simple stalks. Petals white, ribbed; the three outermost elliptical; the rest rather broader and obovate; each of the six is said by Gærtner to be marked with two green spots below the middle. Commerçon describes three of them only as having a pair of obsolete glands at their base. Berry the size of a pea.

2. *E. buxifolia*. (*Philesia buxifolia*; Willd. Sp. Pl. v. 2. 231.) Inner petals thrice as large as the outer. Leaves with numerous transverse veins.—Commerçon alone seems to have found this fine species, in the Straits of Magellan. Lamarck's plate, drawn from one of his dried specimens, is a very just representation. We have received several of these from Thouin and Jussieu. The shrub is two or three feet high, with the aspect of box, much branched and smooth. Leaves stalked, an inch long, elliptic-oblong, pointed, revolute; green, smooth, with a longitudinal furrow above; glaucous, with a central prominent rib, a marginal one at each edge, and numerous transverse veins, beneath: their edges are rough with minute teeth near the point. Flowers terminal (not axillary), large and very handsome, apparently reddish; their three outer petals elliptical, flat, about half an inch long; the three inner obovate, thrice as long; all veiny. We presume to unite these two plants under one genus, the differences described in their stigmas having no foundation in truth, and there being a sufficient difference between the outer and inner petals of the first, to shew that a more striking difference of the same kind in the second can only make a specific, not a generic, distinction. S.

ENARGIA, *Εναργεια*, in Rhetoric, a figure, which passing from the narrative style, points out, and as it were, sets the subject before the eyes of the audience. Voss. Rhet. lib. iii. p. 361.

ENARTHROSIS, in Anatomy, is that kind of joint, in which a rounded head of one bone is received into a cup-like hollow of another. See DIARTHROSIS.

ENBAR, in Geography, a town of Asiatic Turkey, in the Arabian Irak, on the Euphrates; 40 miles west of Bagdad.

ENBORNE, a parish in the hundred of Kentbury, Eagle, Berkshire, England, is situated 59 miles from London, and contains 46 houses, and 275 inhabitants. A remarkable and well-known custom is attached to its manors, that if the widow of a copyholder should marry again, or be guilty of incontinency, she forfeits her free-bench, or life-interest in her late husband's copyhold; which is not recoverable but by her submitting to ride into court upon a black ram, repeating some ludicrous lines, which end with a petition for her husband's land. The steward of the manor is then obliged to reinstate her. At every court, the jury still present this as one of the ancient customs of the place. The penalty has not been literally enforced within the memory of man; but it is said, that a pecuniary commutation has been received in lieu of it, which may perhaps have been more readily accepted, from the difficulty of procuring a proper animal for the purpose. Lyson's Magna Britannia, vol. i.

ENCÆNIA, *Εγκαινια*, a Greek term, signifying re-*stauracion*, or *renovation*, being compounded of the preposition *εν*, and *καινος*, *new*.

ENCÆNIA is more particularly used for the name of a feast celebrated by the Jews on the twenty-fifth of the ninth month, in memory of the dedication, or rather purification

of the temple, by Judas Maccabæus, after its having been polluted and plundered by Antiochus Epiphanes.

The Jews had also two other Encænia, *viz.* the dedication of the temple by Solomon, and that of Zorobabel, after the return from the captivity.

ENCÆNIA is likewise applied in the *Fathers*, and *Church-History*, to the dedication of Christian churches. See DEDICATION.

Our translators of the Bible do not retain the word Encænia, in St. John, x. 22. where mention is made thereof; in lieu of that, they call it "Feast of the Dedication," which is less proper. In effect, it is not the feast of the dedication, but of the purification or re-consecration of the temple profaned, that is there spoken of.

St. Augustine assures us, that in his time the use of the word Encænia was even transferred to profane matters; and that they called it *Encæniare*, when they put on a new suit of clothes.

ENCALYPTA, in *Botany*, from *en*, and *καλυπτω*, covered or veiled, alluding to the extraordinary size of the calyptra or veil, which is a characteristic mark of the genus. Extinguisher-moss; Schreb. 759. Hedw. Sp. Musc. 60. Sm. Fl. Brit. 1180. Turn. 17. (Leerfia; Hedw. Fund. v. 2. 88. Bryum; Linn. Gen. 564. Juff. 11. Hudf. 474. Dill. 338.) Class and order, *Cryptogamia Musci*. Nat. Ord. *Musci*.

Gen. Ch. Male, *Flowers* axillary, composed of imbricated scales. Female on the same plant. *Fl.* terminal, several abortive. *Capf.* stalked, cylindrical, inclining to ovate, erect, regular. *Fringe* simple, of sixteen linear, upright, thin, palish teeth. *Veil* bell-shaped, inflated, membranous, much wider than the capsule, erect, often toothed or fringed at the edge.

Ess. Ch. Capsule cylindrical. Fringe of sixteen linear upright teeth. Veil bell-shaped, inflated, lax.

This is but a small genus, consisting of five species only in Hedwig's Sp. Musc. and of four in the Flora Britannica, to which indeed a new one, *E. alpina*, is added in Engl. Bot. t. 1419. The most common is *E. vulgaris*. "Veil entire and smooth at its margin. Stem nearly simple. Leaves lanceolate." Figured in Engl. Bot. t. 558. (*Bryum extingtorium*); and by Dillenius in his t. 45. f. 8. It occurs not unfrequently on shady banks, and in the crevices of rocks, and is strikingly distinguished by its large and deep veil. *E. streptocarpa*. "Veil contracted and torn at its margin. Stem branched. Leaves oblong. Capsule spirally furrowed." Is the largest and finest species, long much misunderstood by botanists. See its figure in Hedw. Sp. Musc. t. 10. f. 10—15, and Haller's Hist. t. 45. f. 3. Dillenius exhibits the leaves and stem only, t. 43. f. 71.

Mr. Turner, in his *Muscologiz Hibernicæ Spicilegium*, suggests an opinion that this genus is not really distinct from *Grimmia*, and we confess that *E. Daviesii*, Engl. Bot. t. 1281, seems not very justly referred to it. It is certain that the fringes of several *Grimmiæ* have the thin pale aspect supposed essential to *Encalypta*, but their veils are truly those of *Grimmia*.

ENCAMPMENT, in *Military Affairs*, implies the position taken for the night, or for any time, of an army, for the purposes of exercise, or for warfare. It is common in all countries for the regular forces to be called out, at stated periods, especially during favourable seasons, from their barracks or quarters, in order to unite for their acting in concert upon a large scale, and for their being reviewed by some superior officer. These camps are usually pitched on certain large commons, whereon evolutions may be con-

veniently performed by several regiments or brigades, and whose sites are favourable both in regard to salubrity, and the easy supply of water and provisions. When we speak of encampments in a literal sense, we invariably attach thereto the idea of living under canvas; and such is absolutely the case, when troops are called out for the above purposes. But we are not to conclude that in time of war, when on actual service, such takes place on all occasions: far otherwise, for it is a general maxim always to spare the camp equipage, as far as may be practicable; and to keep every thing packed, which is not immediately in requisition: therefore, we usually see regiments, especially of infantry, stationed in towns, with lines of pickets in advance, and along their intervals, when the distances between such towns may not be great, and the enemy not so near at hand as to render such breaks dangerous. Thus, an army of 40,000 men is frequently seen to occupy full 20 miles, or even more, in this manner; the different regiments occupying the several villages along that line, and closing up into more compact arrangement, whenever danger may be apprehended. This manner of disposal not only saves infinite trouble and delay, respecting the camp equipage; but exposes the army less to inclement weather, or to noxious localities; and besides, facilitates its movements very considerably, by allowing the whole to move in separate columns, from one station to another. In this the columns necessarily act nearly parallel, much the same as in the advance of a battalion by the right or left of companies in open column.

Encampments, by which we mean the mode of laying out the camp into streets and divisions, are, with some trifling variation, formed after the same manner in all countries. The general principles are, 1st, That no more ground should be occupied than may be absolutely necessary for the drawing up the troops in order of battle: hence, all additions whatever should be made rather in the depth than in the breadth of the camp. This is done to avoid such breaks as could not fail to weaken the line, and to admit the incursions of the enemy's horse. It is, however, usual to allow the interval of about an eighth of their respective fronts between battalions of infantry, and of 30 or 40 paces between squadrons of cavalry. 2dly, The leaving of passages, or streets, throughout, so that bodies may move from one part to the other without hindrance, and without being compelled to pass along the front of the bells of arms. 3dly, That due precaution should be taken for the prevention of disease, by a judicious arrangement of the regimental and general hospitals, as well as by securing the due facility for the removal of filth, and for abundant ventilation; both which can only be effected by due care founded on the precaution of not allowing the camp to be too crowded, either by its situation, or the number of persons contained therein. It is usual to allow a front of two feet for every file (whether two or three deep) of infantry, and a front of three feet for every file of cavalry: hence camps, wherein the battalions are formed three deep, must have their streets full one-half deeper than where the corps are drawn up only two deep. When the ground may permit, the streets are usually at right angles with the front; each row of tents containing the men of a company, arranged according to their several stations, or numbers, in their companies respectively. Supposing the whole to be standing at the doors of their respective tents, and to be ordered to fall in, they would, by this arrangement, arrive in regular succession, either from right to left, or from left to right, at their several stations. The horses and the tents of a troop of cavalry are arranged in a similar manner. The grenadiers and light infantry are ordinarily encamped in single rows,



admit of in one row; then the number of rows being multiplied, by the breadth of one in front, will give that part of the front to be occupied by the rows; and the difference between it and the whole front allowed for the battalion, or squadron, will be left for the streets; which, if the streets are to be equal, must be divided by their number, to find the breadth of each; or is, otherwise, easily divided into streets of unequal breadths.

When two guns are attached to a battalion, they are posted on the right in the following order; from the right of the battalion to the centre of the first gun, four yards; from this to the second gun, six yards. The muzzles of the guns in a line with the serjeants' tents. The subalterns of artillery, if any, in a line with the subalterns of infantry; the rear of the gunners' tents in a line with the rear of the battalion tents.

The park of artillery should always be placed, if practicable, within a short distance of water carriage, and have the most ready communication with every part of the line. Its form must depend on its situation. Ten feet are usually allowed in front for one carriage and its interval, and about fifty yards from the hind wheels of the front row to the fore wheels of the second: this interval should allow sufficient room for putting the horses to the carriages, and for a free passage along the line. In parks not on immediate service, it is usual to arrange the guns with their muzzles to the front, but where the guns are likely to be wanted at a short notice, appearances must give way to promptness, and the gun-carriages must be parked with their shafts to the front, ready to receive the horses, or other draught animals.

A quarter-guard is placed in front of the park, and the non-commissioned officers' and gunners' tents on the flanks, at about twenty paces distant; forty paces to the rear are the subaltern officers' tents; at ten more the rear of the captains; and ten more to the front of the commanding officers: the mess-tent is fifteen paces in rear of the line of officers. At a convenient distance, in the rear of the whole, are the horses, picketed in one or more lines, with the drivers on their flanks. The horses are sometimes picketed in lines perpendicular to the front of the park, and on the flanks of the carriages, between the men and the carriages.

An army is sometimes encamped in two, or even in three, or more lines; according to its numbers, and the nature of the ground. The distance between two lines must depend entirely on local circumstances, or on the object in view: sometimes they are not more than two hundred yards asunder, and sometimes full five or six hundred; occasionally they are pitched in reverse, especially when covering a convoy that has taken post between two hills, or rivers, or woods; in such instances they are "in reverse," and, in lieu of rear guards, have a central force to act as a reserve.

With respect to the choice of ground for an encampment, it must be recollected that no position is tenable, in a military point of view, which does not stand exempt from the enfilade of an enemy. In fact, all commanding grounds ought to be beyond the reach of cannon, so that the camp should not be subject to molestation from such situations. Four principal objects demand attention in the choice of a position for encampment. 1st. The advantages of the ground, as arising naturally, in point of defence. 2d. The access to, or the possession of, supplies for the army. 3d. The particular object to be attained; whether mere security, the covering of any depot, the cutting off of an enemy's resources, the communication with other parts, and

especially with shipping. 4th. The means of retreat if too closely pressed by a superior force.

The front of an encampment, or, as already explained, of a position, should be intersected by rivers, ravines, or broken grounds, or any other obstacles which may prevent the enemy from advancing in order of battle, and oblige him to pass through defiles: but the front should nevertheless be exempt from such obstacles as might debar the army from moving out of its camp, or advancing when necessary. All obstacles ought to be within reach of the artillery, or the enemy will pass them unmolested. In a flat country, where the ground does not afford commanding situations, a position is more or less eligible according as it may be covered by obstacles; such as very thick woods, in which there are few roads; large rivulets that cannot be crossed but by means of bridges; deep and broken ravines; ground much intersected by ditches and hedges; the possession of mills, churches, convents, and other buildings that are capable of obstinate defence, and are within the encampment. A situation where the rear is covered by swamps has certain advantages, but is attended with this danger, that, in case of defeat, retreat must be difficult, if at all practicable. The principal obstacles, if a choice can be made, ought to be thrown upon the flanks, and force the enemy to narrow his front when attacking the encampment; but, if such obstacles should be of a nature to be easily possessed by him, they will prove peculiarly exceptionable, and ought not to be depended upon, any more than the supply of water from ponds, wells, or streams that lie exposed to his interference. Lastly, the want of wood, or of water, even though provisions should be abundant, totally disqualify a position; unless, indeed, for a very short occupancy, and rather as a resting place than an *appui*, or defensive aid. These deficiencies must invariably operate, on large armies especially, so as to render such situations untenable, whatever advantages they might offer in regard to natural strength, or distress occasioned by their occupancy, to the enemy.

ENCANTHIS, a term in *Surgery*, derived from the Greek *en*, signifying *in*, and *kanthos*, which implies the *angle of the eye*. By a kind of abuse of words, which is too common in every language, the Greek writers have applied the name of "encanthis" to a small, roundish, unequal, more or less considerable, sometimes red, at other times light-coloured tumour, situated in the caruncula lachrymalis, which every surgeon knows is naturally placed near the angle of the eye.

Professor Scarpa, of Pavia, has surpassed every author, with whom we are acquainted, in the excellent and interesting account which he has given of the disease under consideration. To him we feel highly indebted for a great deal of the matter, which we are about to insert. He observes, that the incipient encanthis is a small, soft, reddish, or sometimes slightly livid, excrescence, which grows from the caruncula lachrymalis, and also from the adjacent semi-lunar fold of the tunica conjunctiva. In general, the inveterate encanthis is of very considerable size, its roots reaching beyond the caruncula lachrymalis and semi-lunar fold of the conjunctiva, and extending along the membranous lining of one, or both eye-lids. In consequence of its being situated between the internal commissure of the eye-lids, which it hinders from becoming closed on the side next the nose, it subjects the patient to a great deal of inconvenience, by keeping up a chronic ophthalmia, obstructing the action of the eye-lids, and, in particular, by rendering the patient incapable of shutting his eye. Also, partly by compressing the orifices of the puncta lachrymalia, and partly by altering their natural direction, the encanthis becomes an impediment

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ment to the free passage of the tears from the eye into the nose.

The encanthis, in its early state, has usually a granulated appearance, like a mulberry; or else it is composed of little portions resembling fringe. When the excrescence has attained a considerable size, a certain part of it has a granulated appearance, while the remainder looks like a smooth, whitish, or ash-coloured substance, streaked with varicose vessels, and sometimes extends so far over the conjunctiva, covering the side of the eye-ball next the nose, that it reaches to the place where the cornea and sclerotica meet. When the encanthis has increased to this considerable pitch, it constantly affects, together with the caruncula lachrymalis and semi-lunar fold of the conjunctiva, the membranous lining of one, or both eye-lids. In this state, it may be observed, that the excrescence, besides the roots, which it derives from the caruncula lachrymalis, and conjunctiva, has a firm prominent appendage, or elongation, which extends along the inner surface of the upper, or lower eye-lid, in the direction of its edge. In other terms, we may state, that the middle portion, or body (as it were) of the encanthis, near the cornea, divides, in the form of a swallow's tail, into two appendages, or elongations, one of which extends along the inside of the upper eye-lid, covered by the edge of this part, while the other is continued along the inner surface of the lower eye-lid, concealed under its margin, and proceeding in the direction from the internal towards the external canthus of the eye.

Scarpa remarks, that the body of the encanthis, or that middle portion of the excrescence, which reaches from the caruncula lachrymalis and semi-lunar fold inclusively, over the conjunctiva of the eye-ball, even to the very edge of the cornea, is sometimes as prominent as a common nut or a chestnut. In other instances, it is of the same size, but depressed and flattened, as it were, in the middle. However, the body of the excrescence does not now retain the same granulated appearance which it presented at an earlier period, while one, or both the appendages, extending along the inner surface of one, or both eye-lids, seem more like a fleshy, than a granulated substance.

When the eye-lids are turned out, these appendages of the encanthis form a projection forward, and when this is observable on both palpebræ, on their being turned out in this manner, the two fleshy appendages make together a kind of ring, which comes into close contact with the globe of the eye behind. Scarpa informs us, that Fabricius Hildanus was acquainted with this disease, which he succeeded in curing, and which he named *ficus scirrhusus ad majorem oculi canthum*. See *Centur. 1. Obs. 2.*

However, Scarpa takes notice, with respect to the case recorded by Hildanus, that the encanthis had only one appendage, which was situated on the inner surface, and below the margin, of the upper eye-lid.

Scarpa, in conformity with most surgical writers, has very accurately explained, that the encanthis, as well as the pterygium, occasionally puts on a cancerous malignity, which is denoted by the dark-red, or leaden colour of the tumour; by its unusual degree of hardness; by its darting pains, which extend to the forehead, and all over the eye and temples, particularly whenever the excrescence has been even gently touched; by its tendency to bleed; and, lastly, by the ulcerations, which occur in several places, emit a fungous growth, and discharge a thin irritating sanies. Scarpa is of opinion, that this worst form of the encanthis can only receive palliative treatment, unless an attempt at extirpation be made, by removing, together with the disease, all the parts contained in the orbit, the success

of which operation he also represents as exceedingly doubtful.

At the same time, that we profess the highest respect for the sentiments of Scarpa in general, on the subject of discharges of the eyes, we cannot silently subscribe to his advice, that no endeavour should be made to effect a radical cure of any malignant encanthis, without extirpating all the contents of the orbit. If the disease were not so very extensive, as to prevent the surgeon from making a fair removal of every part of it, without taking away the eye itself, what practitioner can doubt, that the latter formidable operation ought to be dispensed with. It would be full time enough to have recourse to this severe step, when it had been decidedly evinced, that cutting away the diseased parts alone was insufficient, and that malignant morbid mischief still prevailed.

Scarpa informs us, that the benign encanthis, whether of small, or considerable size, may be cured by excision. The small beginning encanthis, whether of a granulated or fringed appearance, and originating from the caruncula lachrymalis and semi-lunar fold, or, also, from a small portion of the margins of the eye-lids, where they form the internal commissure, may be raised with a pair of forceps, and be completely cut away closely to its base with the curved scissors. In order to accomplish this operation, it is needless to follow the plan, which some adopt, of introducing a needle and thread through the little excrescence, with a view of raising and detaching it more accurately from the parts, to which it is adherent. This object can be fulfilled with the forceps, without annoying the patient by the punctures, and by drawing a thread through the tumour, for the purpose of making a noose. However, in taking away such portion of the incipient encanthis, as arises from the caruncula lachrymalis, Scarpa very prudently cautions us against removing more of the substance of that body, than the complete eradication of the disease requires, lest the loss of too much should occasion an irremediable flux of tears from the eye.

When the little excrescence has been extirpated, the eye ought to be repeatedly washed with cold water to get away the blood, and should then be covered with a piece of fine linen and a retentive bandage. About the fifth, sixth, or seventh day, as soon as the inflammation, produced by the operation, has quite subsided, and suppuration from the wound has commenced, Scarpa advises us to touch the cut surface with a small button of alum, scraped into the shape of a crayon-pencil, and he also recommends a collyrium, containing the zincum vitriolatum and mucilage of quince-seeds, to be frequently applied to the eye in the course of the day. If this plan of treatment should not have the desired effect of making the wound heal; but, on the contrary, if the cut surface of the caruncula lachrymalis and internal angle of the eye should, instead of continuing to heal up, put on a fungous appearance, it should be repeatedly touched with the argentum nitratum, care being taken not to apply this caustic to the conjunctiva, more particularly, if any part of this membrane should have been wounded. After the destruction of the fungous granulations, a collyrium, containing the zincum vitriolatum, will accomplish the cure, or the practitioner may introduce between the eye-ball and internal commissure of the eye-lids, three times a day, an ointment composed of fresh butter, powdered tutty, and armenian bole. Scarpa also acquaints us, that Bidloo speaks much in favour of using for the latter purpose powdered chalk, either alone, or mixed with calcined alum. See *Exercit. Anat. Chir. Decad. 2.*

Scarpa informs us, that we may also cut away the large inveterate

inveterate encanthis, either with a flat body, or with one, which projects in the shape of a common nut, or chestnut, and having one, or two fleshy appendages extending along the lining of one or both the eye-lids. In this instance, a ligature cannot be properly made use of, because the neck of the tumour is never small enough to allow of being advantageously tied. On the contrary, the encanthis, when it is very large, is always extensively connected with the caruncula lachrymalis, and with the conjunctiva, almost as far as where the cornea begins, and it has, moreover, one or two fleshy appendages, which run along the under surface of one or both the eye-lids. For this reason, even should the middle part of the encanthis be extirpated with a ligature, still one or both the appendages would stand in need of removal, which object could only be accomplished by excision.

The apprehension of the bleeding from the latter operation is quite unfounded, as there are numerous cases on record, where the operator has cut away a large inveterate encanthis, without any ill arising from hemorrhage. Scarpa mentions, that he could relate himself some cases which he has met with, in confirmation of the truth of the foregoing statement. This candid writer, however, does not dissimble, that Pellier records an example, in which a troublesome degree of bleeding followed the excision of an encanthis; but, it is justly observed, that the particulars of the disease are undescribed, as well as the exact way in which the operation was performed. Had these circumstances been detailed, perhaps they would have explained the reason of the unusual occurrence. Indeed, Pellier himself has remarked, "j'ai souvent fait cette operation a des excroissances de cette nature, et jamais je n'ai éprouvé un pareil accident."

In the case of the large inveterate encanthis, referred to above, and in which there was only one appendage continued along the inside of the upper eye lid, Hildanus, after taking hold of the body of the encanthis with a tentaculum, drawing the tumour towards him, and turning out the upper eye-lid, in order to make the whole of the appendage project forward, detached all this last portion from the inside of the eyelid with a small knife, and afterwards cut away the body of the encanthis from the conjunctiva and caruncula lachrymalis. Scarpa remarks, that as this plan was attended with complete success, it ought to be imitated by all practitioners.

However, when the inveterate encanthis, of large size, has two apperidges, one reaching along the inner surface of the upper eye-lid, the other along that of the lower one, Scarpa advises the following plan to be adopted. The patient is to be seated in a chair, and the upper eye-lid turned out by an assistant, so as to make one of the apperidges of the encanthis project forward. This production of the disease is to be deeply cut into with a small knife, in the direction of the edge of the eye-lid, taken hold of with a pair of forceps, and be completely detached from the inside of the part, in the longitudinal direction, the dissection being continued from the external towards the internal angle of the eye, as far as the body of the encanthis. The appendage on the inner surface of the lower eye-lid should be separated in the same way. Then the middle portion of the encanthis should be lifted up with a pair of forceps, or, (if this cannot be done) with a double hook, and be entirely cut away from the conjunctiva underneath, which covers the eye ball, and from the semi-lunar fold, and caruncula lachrymalis. This may be accomplished partly by means of a small knife, and partly with the aid of curved scissors. The operator is also to cut more or less deeply into the caruncula lachrymalis, according as the strength and depth

of the roots of the disease may require; for, it must be confessed, that, when the encanthis is very large, and of long standing, the surgeon cannot always avoid wounding the caruncula lachrymalis sufficiently to prevent some degree of weeping from the eye, after the operation.

The eye should be repeatedly bathed with cold water, and the rest of the treatment is nearly like that recommended after removing a small incipient encanthis. Scarpa recommends the use of collyria of aqua malvæ, and of anodyne and detergent ones, until suppuration has fully taken place from the surface of the wound. Then mild astringents, and the above-mentioned ointment may be usefully had recourse to. Scarpa particularly advises giving a preference to mild applications, both before and after suppuration has taken place, especially when a considerable piece of the conjunctiva, covering the white of the eye, has been cut away with the encanthis. See Scarpa Sulle Principali Malattie degli Occhi.

ENCARDION, from καρδια, *heart*, in *Botany*, a name given by the Greeks to what the Latins properly call the mediata in trees, the heart of the wood, or central hard part of it.

ENCATHISMA, from εγκαθισμα, *I sit in*, in the *Medical Writings of the Ancients*, a term used to express a sort of bath, in which the patient was only to be plunged up to the belly.

ENCAUMA, from εν, and καω, *to burn*, in *Surgery*, the mark left by a burn; also a small abscess arising from the same cause. The term is sometimes applied to a superficial ulceration on the eye.

ENCAUSIS, from εν, and καω, *to burn*, a burn, or the inflammation produced by this sort of injury; also the operation of external heat on the body, as of the sun, or fire. In Dr. Cullen's *Nofology*, the word is synonymous with erythema and ambustio.

ENCAUSSE, in *Geography*, a small town of France, in the department of the upper Garonne; 12 miles E. of St. Bertrand, remarkable for its springs of mineral water.

ENCAUSTIC PAINTING, εγκαιστικον, from εν, καω, *inuro*, *I burn in*, is a species of painting with burnt wax, practised by the ancients, and lately revived. Pliny has given the following brief account of the invention and nature of this art: "Cæris pingere ac picturam inurere, quis primus excogitaverit non constat; quidam Aristidis inventum putant, postea consummatum à Praxitele; sed aliquanto vetustiores encausticæ picturæ extitere, ut Polygnoti, & Nicanoris, & Arcefilai, Pariorum Lysippus quoque, Eginæ picturæ suæ inscripsit ενκαυστων; quod profectò non fecisset, nisi encaustica inventa. Pamphilus quoque Appellis præceptor non pinxisset tantùm encaustica, sed etiam docuisse traditur Pausaniam Sycionium, primum in hoc genere nobilem." Lib. xxxv. cap. 11. From this paragraph we learn, that the method of painting in wax, and burning in the picture, was very ancient; nor is it improbable that in former times, when they were unacquainted with dry oils, and transparent varnishes, they should make use of this method for preserving their colours from damps and heats; though some imagine, that by *cæris* is meant a composition, different from wax, and capable of bearing the fire; and that burning the picture denotes merely enamelling. Pliny in the same chapter informs us, that there were anciently two methods of encaustic painting in use: "Encausto pingendi duo fuisse antiquitùs genera constat, cerâ & in ebore, cestro, *i. e.* viriculo: donec classes pingi cæperè. Hoc tertium accessit, resolutis igni ceris, penicillo utendi; quæ pictura in navibus nec sole, nec sale, ventisque corrumpitur." Dr. Parsons maintains, that the *cestrum* was a pointed tool used in modelling

delling or carving upon ivory or wax; and he supposes that there is a contrast between the use of the *castrum*, and painting ships with a brush, and therefore that the term *pingendi* cannot be understood to mean the laying on of paint. However, there is a passage in Vitruvius, lib. vii. cap. 9. which serves to ascertain the nature of the ancient encaustic painting. "At si quis subtilior fuerit, & voluerit expositionem miniaceam suam colorem retinere, &c." *i. e.* if any one is more wary, and would have the polishing, or painting, with vermilion hold its colour, when the wall is painted and dry, let him take Carthaginian wax, melted with a little oil, and rub it on the wall with a hair-pencil; and afterwards let him put live coals into a chafing-dish, and hold it close to the wax; when the wall, by being heated, begins to sweat, let it be made smooth; afterwards let him rub it with wax tapers, and clean linen rags, in the same manner as they do the naked marble statues. This the Greeks call *μαζα*. The coat of Carthaginian wax is so strong, that it neither suffers the moon by night, nor the sun-beams by day, to destroy the colour. From this passage we learn the ancient method of painting in wax by inuision, more obscurely expressed by Pliny; though Pliny, in another passage, expressly informs us, that they used coloured wax: "Cerae (he says) tinguntur iisdem his coloribus, quæ inurantur;" that they employed a pencil to lay on the melted wax; "resolutis igni ceris, penicillo utendi;" that the picture was fixed by inuision, "picturam inurere." And we learn from Vitruvius, that the whole was cleaned and polished with linen rags.

The Punic or Carthaginian wax, the use of which is ascribed to the ancient painters by Varro, Vitruvius, and Pliny, was said to be the best, as it exceeded in whiteness the Sardinian and Corsican, probably because it was better purified; for the Africans, as we learn from Pliny, were accustomed to use alkali in order to render this substance whiter, and also to free it, as some have supposed, from all greasy matter. Wax, however, seems to have formed the only ground of wax-painting. The abbé Requeno, who contributed to present to the notice of modern painters wax-painting, adds mastic; but Lorgna converts his wax into soap, as Bachelier does with the alkali of Soda. Astori adds gum and honey, affirming that thus the wax would be rendered much more yielding and softer for the brush. Requeno seems to assign the exclusive possession of this art to the Greeks and Romans; but we have reason for believing that the knowledge and use of encaustic painting were older than their time, because the Egyptians, who with the Etruscans were the parents of the greater part of the inventions known among mankind, and from whom the Greeks derived much of their knowledge, were acquainted with and employed encaustic painting in the ancient ages of their greatness and splendour. This fact has been deduced from valuable fragments of the bandages and coverings of mummies painted in this manner. A mummy of this kind is mentioned in a treatise entitled "Antichita, &c." referred to at the close of this article. No oil-painting, it is said, perhaps only two or three hundred years old, exhibits a white paint that has kept so well as that seen on the fragment to which we have alluded; and this circumstance sufficiently proves the valuable advantage which that method possesses when compared with the common oil-painting. The wax, instead of becoming black by the contact of the atmosphere, as drying oil does, acquires increasing whiteness, and according to its natural quality, is not decomposed in the air, and does not strongly attract the oxygen of the calces or metallic ashes, which are commonly used in painting. That beautiful white, which may be observed in the Egypt-

ian encaustic above-mentioned, is, as the author of the treatise just cited apprehends, nothing else but a simple earth, and according to his chemical experiments a chalk (*creta*), which is also unalterable. If we consider this encaustic fragment, says our author, as belonging to the epoch of the first violent change, which the religious system of the Egyptians experienced, it will be a specimen of painting about 2500 years old; for such is the number of the years that have elapsed since Cambyzes overturned the ceremonies and religious worship of the Egyptians, not only by the sword, but by the still more powerful weapons of ridicule. Dead bodies were embalmed there in the time of Herodotus, (see EMBALMING); but the cloth in which they were wrapped, or the bandages bound round them, were no longer painted with sacred characters. The bodies were only inclosed in wooden cases, which were more or less ornamented. If Bochart and Ménage be not mistaken, the name "mummiæ" is derived from "muim," which signifies wax; and one might therefore believe, that the dress of embalmed bodies was thus named because wax was employed for painting it; and thence it would follow, that the fragment in question may be classed among the oldest. Petronius praises the fresh appearance which the valuable works of Zeuxis and Apelles had, even in his time; but Cicero, on the other hand, speaks of the paintings of the ancients having suffered from blackness. The former is supposed to have spoken of wax-painting, and the latter is presumed to have alluded to paintings in oil. The author, whose sentiments we are now expressing, detached 24 grains of the encaustic painting from the above-mentioned Egyptian fragment; and in his mode of examining it, the mixture of 100th part of a foreign substance would have been discovered with the greatest certainty: he must, he says, have perceived the resin of Requeno, nor could the alkali of Bachelier and Lorgna have escaped his notice. But in this Egyptian encaustic he found nothing except very pure wax, though he varied his analysis in every known method.

From the words of Vitruvius above cited it appears, that the Romans, who copied the Grecian process, which was borrowed from the Egyptians, mixed the wax with an oil to make it pliable under the brush, but no mastic, alkali, or honey, as some have imagined, was employed; what this oil was it is not easy to ascertain. It does not appear that they used those fat oils, which are commonly called drying oils, because they could have employed those as we do, without the addition of wax, which would have been altogether superfluous. Fat oils, which do not dry, would not have been proper for that purpose, as they would have kept the wax continually in a soft state. Our author supposes, that the Egyptians, in order to use wax in their encaustic painting, must have combined it with an ethereal volatile oil, of which no traces should afterwards remain, and that though they might be unacquainted with the art of separating ethereal oils from the many substances which they contain, they certainly were acquainted with a very volatile thin oil produced by nature, and which in various places issues from the earth. This oil was either that called naphtha, which is an exceedingly volatile oil, that entirely flies off and evaporates, without leaving a single trace behind; or the common spirit of turpentine, which would very well answer the purpose. The encaustum, thus formed, was used in the time of the Romans to cover parts, which had been already painted either with water-colours or in fresco; and it was also, as we have reason to believe, the substance with which Apelles daubed over his paintings, and which, according to Pliny, made them appear as if covered by a thin plate of talc or transparent selenite, and gave the colours a wonderful soft-

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ness. It might still be employed for preserving paintings in water-colours, or on plaster, and sculptured pieces of marble.

The ancient art of encaustic painting, after having been long lost, was restored by count Caylus, a member of the Academy of Inscriptions in France; and the method of painting in wax was announced to the Academy of Painting and Belles Lettres, in the year 1753; though M. Bachelier, the author of a treatise "De l'Histoire & du Secret de la Peinture en Cire," had actually painted a picture in wax in 1749; and he was the first who communicated to the public the method of performing the operation of infusion, which is the principal characteristic of the encaustic painting. The count kept his method a secret for some time, contenting himself with exhibiting a picture at the Louvre in 1754, representing the head of Minerva, painted in the manner of the ancients, which excited the curiosity of the public, and was very much admired. In the interval of suspense, several attempts were made to recover the ancient method of painting. The first scheme adopted was that of melting wax and oil of turpentine together, and using this composition as a vehicle for mixing and laying on the colours. But this method did not explain Pliny's meaning, as the wax is not burnt in this way of managing it. In another attempt, which was much more agreeable to the historian's description of encaustic painting, the wax was melted with strong lixivium of salt of tartar, and with this the colours were ground. When the picture was finished, it was gradually presented to the fire, so as to melt the wax; which was thus diffused through all the particles of the colours, so that they were fixed to the ground, and secured from the access of air or moisture. But the method of count Caylus is much more simple: the cloth, or wood which he designed for the basis of his picture, is waxed over, by only rubbing it simply with a piece of bees' wax; the wood, or cloth, stretched on a frame, being held horizontally over, or perpendicularly before a fire, at such a distance, that the wax might gradually melt, whilst it is rubbed on, diffuse itself, penetrate the body, and fill the interstices of the texture of the cloth, which, when cool, is fit to paint upon; but as water-colours, or those that are mixed up with common water, will not adhere to the wax, the whole picture is to be first rubbed over with Spanish chalk or white, and then the colours are applied to it; when the picture is dry, it is put near the fire, whereby the wax melts, and absorbs all the colours.

Mr. J. H. Muntz, in a treatise on this subject, has proposed several improvements in the art of encaustic painting. When the painting is on cloth, he directs it to be prepared by stretching it on a frame, and rubbing one side several times over with a piece of bees'-wax, or virgin's-wax, till it is covered with a coat of wax of considerable thickness. In fine linen, this is the only operation necessary previous to painting; but coarse cloth must be rubbed gently on the unwaxed side with a pumice stone, to take off all those knots, which would prevent the free and accurate working of the pencil. Then the subject is to be painted on the unwaxed side with colours prepared, and tempered with water; and when the picture is finished, it must be brought near the fire, that the wax may melt and fix the colours. This method, however, can only be applied to cloth or paper, through the substance of which the wax may pass; but in wood, stone, metals, or plaster, the former method of count Caylus must be observed.

Mr. Muntz has also discovered a method of forming grounds for painting with crayons, and fixing these, as well as water colours, employed with the pencil. On the

unwaxed side of a linen cloth, stretched and waxed as before, lay an even and thick coat of the colour proper for the ground; having prepared this colour, by mixing some proper pigment with an equal quantity of chalk, and tempering them with water. When the colour is dry, bring the picture to the fire that the wax may melt, pass through the cloth, and fix the ground. An additional quantity of wax may be applied to the back of the picture, if that which was first rubbed on should not be sufficient for the body of colour; but as this must be laid on without heat, the wax should be dissolved in oil of turpentine, and applied with a brush, and the canvas be again exposed to the fire, that the fresh supply of wax may pass through the cloth, and be absorbed by the colour; and thus a firm and good body will be formed for working on with the crayons. If cloth and paper are joined together, the cloth must be first fixed to the straining frame; and then the paper must be passed to it with a composition of paste made with wheaten flour, or starch and water, and about a twelfth part of its weight of common turpentine. The turpentine must be added to the paste when it is almost sufficiently boiled, and the composition well stirred, and left to simmer over the fire for five or six minutes; let wax be dissolved in oil of turpentine to the consistence of a thin paste; and when the cloth and paper are dry, let them be held near a fire; and with a brush lay a coat of the wax and turpentine on both sides the joined cloth and paper, in such a degree of thickness, that both surfaces may shine throughout without any appearance of dull spots. Then expose the cloth to the fire or to the sun; by which means the oil will evaporate, and the wax become solid, and be fit to receive any composition of colour for a ground, which is to be laid on as above directed in the case of cloth without paper.

Almost all the colours that are used in oil-painting may be also applied in the encaustic method. Mr. Muntz objects, indeed, to brown, light pink, and unburnt *terra di Sienna*; because these, on account of their gummy or stony texture, will not admit such a cohesion with the wax as will properly fix them; but other colours, which cannot be admitted in oil-painting, as red-lead, red-orpiment, crystals of verdgris, and red precipitate of mercury, may be used here. The crayons used in encaustic painting are the same with those used in the common way of crayon painting, excepting those that in their compositions are too tenacious; and the method of using them is the same in both cases.

The encaustic painting has many peculiar advantages; though the colours have not the natural varnish or shining which they acquire with oil, they have all the strength of paintings in oil, and all the airiness of water-colours, without partaking of the apparent character or defects of either; they may be looked at in any light and in any situation without any false glare; the colours are firm, and will bear washing; and a picture, after having been smoked, and then exposed to the dew, becomes as clean as if it had been but just painted. It may also be re-touched at pleasure, without any detriment to the colours; for the new colours will unite with the old ones, without spots, as is the case in common size painting; nor is it necessary to rub the places to be re-touched with oil, as in oil pictures; it is not liable to crack, and easily repaired, if it should chance to suffer any injury. The duration of this painting is also a very material advantage; the colours are not liable to fade and change; no damp can affect them, nor any corrosive substance injure them; nor can the colour fall off in shivers from the canvas. However, notwithstanding all these and other advantages enumerated by the abbé Mazeas, and Mr. Muntz, this art has not yet been much practised. Many of these

properties.

properties belong to a much higher species of encaustic painting lately discovered in England, the colours of which are fixed by a very intense heat; nor are the colours, or grounds, on which they are laid, liable to be dissolved or corroded by any chemical menstruum, nor, like the glassy colours of enamel, to run out of the drawing on the fire. See on this subject, Phil. Trans. vol. xlix. art. 100. p. 652. art. 101. p. 655. Id. vol. li. art. 8. p. 40. art. 9. p. 53. Muntz's Encaustic Eloge of Count Caylus, in the Hist. de l'Acad. Roy. des Inscriptions & Belles Lettres, vol. xxxiv. Antichita, Vantaggi e Metodo della Pittura Encaustica; Memoria del Ch. Sig. Gio. Fabbroni, &c. Roma, 1797, 4to. Handmaid to the Arts, &c. vol. i. ch. ix. p. 245. 261.

ENCAUSTICE has been sometimes used to denote the art of *enamelling*, which see.

ENCAUSTUM CERULEUM, is a name given to powder blue.

ENCAUSTUM SACRUM, a name given, by many authors, to that fine red colour used for illuminating the capital letters in some old manuscripts. Procopius calls it *baphe*, some have called it *coccus*, and some *cinabar*. It is said that it was made of the purple colour, extracted from the murex, or purple fish, with some other additions. It is to be observed, that however well this colour, when laid on the parchment, or paper, might resemble the colours of enamel, yet it was as improper to call it encaustum, which signifies a "colour burnt in," as in enamelling it would have been to have called it atramentum, or ink.

ENCEADA DA BELA, in *Geography*, a town of Africa, in the kingdom of Adel, on the coast of the Indian sea; 30 miles S. of cape Guardafu.

ENCEINTE, Fr. from *enceindre*, to surround, in *Fortification*, the wall or rampart which surrounds a place, sometimes composed of battions and curtains either faced or lined with brick or stone, or only made of earth.

The enceinte is sometimes only flanked by round or square towers, which is called a Roman wall.

ENCELIA, in *Botany*, Jusl. 186. Cavanilles Ic. v. t. 44, t. 61, and v. 3. 6. t. 210. see PALLASIA.

ENCEPHALI, in *Medicine*, a term employed by some writers to signify certain worms, said to be generated in the head.

ENCEPHALITES LAPIS, in *Natural History*, the name given, by authors, to a sort of coarse stone, supposed, in some degree, to resemble the human brain. We have, in the fossil world, many stones, named from the parts of animals, which they have, in reality, been formed from, or owed their original to; and these are properly enough called by names denoting the things whose forms they wear; but it is a very wrong practice, from some slight external resemblances, to give such names to things that never can have been supposed to be so entitled to them. No one can be so absurd as to imagine a human brain can be petrified, though a stone may accidentally somewhat resemble its form. The person possessed of such an accidental specimen, should have ranked it among the stones to which it properly belonged as a stone, whether a flint, a pebble, or a nodule, and have named, as an accident only, this form of it; and not have given it a peculiar denomination, as if it were a new species.

ENCEPHALOCELE, from *εγκεφαλος*, the brain, and *κηλη*, a tumour, in *Surgery*, a hernia of the brain. See FUNGUS.

ENCEPHALON, from *εν*, in, and *κεφαλη*, the head, in *Anatomy*, should signify, according to its etymology, all the parts contained in the head; but it is commonly applied to the brain, as consisting of cerebrum, cerebellum, and

medulla oblongata, exclusive of the surrounding and containing membranes. Hence, Soemmerring's *tabula basalis encephali* is a representation of the basis of the brain. See BRAIN.

ENCEPPE, in *Heraldry*, denotes chained, or girt round the middle; as is usual with monkeys, &c.

ENCERIS, in *Pharmacy*, a word used by Galen to signify small concretions of wax, which formed themselves in melted plasters, of which wax was one of the ingredients. As they cooled, the wax cooling first, and collecting itself into little grumes, spoiled the consistence and form of the whole composition.

ENCHANTMENT, of *in*, and *canto*, I sing, denotes certain words and ceremonies used by magicians in the practice of their pretended and deluding art; thus called, because the formulæ of their enchantment were generally composed in verse, and designed to be sung. See CHARM, FASCINATION, MAGIC, SORCERY, and WITCHCRAFT.

ENCHARAXIS from *εν*, and *χαρισσα*, to scarify, in *Surgery*, a scarification.

ENCHASING, or CHASING, the art of enriching and beautifying gold, silver, and other metal-works, by some design or figures represented thereon, in low relieve. See SCULPTURE, RELIEVO, &c.

Chasing is only practised on hollow, thin works; as watch-cases, cane-heads, tweezer-cases, or the like. It is performed by punching or driving out the metal to form the figures from within side, so as to stand out prominent from the plane or surface of the metal.

In order to this, they have a great number of fine steel blocks, or punches, of divers sizes; and the design being drawn on the surface of the metal, they apply the inside upon the heads or tips of these blocks, directly under the lines or parts of the figures. Then, with a fine hammer, striking on the metal sustained by the block, the metal yields, and the block makes an indenture or cavity on the inside; correspondent to which, there is a prominence on the outside, which is to stand for part of the figure.

Thus the workman proceeds to chase and finish all the parts, by successive applications of the block and hammer to the several parts of the design.

And it is surprising, with what beauty and justness, by this simple piece of mechanism, the artists in this kind will represent foliage, grotesques, animals, histories, &c.

ENCHEIREISIS, *Ενχειρησις*, from *εν*, in, and *χειρ*, a hand, in *Anatomy*, denotes manual operation; as dissection.

ENCHELIS, in *Zoology*, a genus of *Vermes Infusoria*, described essentially as being invisible to the naked eye, very simple, and cylindrical. Nearly all the species are found in stagnant water.

#### Species.

PYRUM. Inversely conic, behind transparent. Müll.

Common in stagnant waters, where the duck-weed grows. Body obtuse, and filled with molecules; and when at rest, appears to have a small tubercle in the middle of the body. This kind is remarkable for the rapidity of its motion.

SPATHULA. Cylindrical, striated, with a transparent spatulate tip. Müll.

Less frequent than the last, and found in waters in which the duck-weed is infused. The body is crystalline, and the creature moves in an undulate manner.

PAPULA. Cylindrical, with the tip papillary. Müll.

Found in the water of dunghills. The body is round, protuberant, opaque before, and furnished with a papillary finger-shaped head; pellucid behind, and both ends obtuse. Its motion is rotatory and oblique.

**FRITILLUS.** Cylindrical, truncated anteriorly. Müll. Hermann.

Met with in water in which grafs or hay is infufed. The body is pellucid, convex, and obtufe behind; moves backwards and forwards with a wafing agitation in a line.

**OVULUM.** Cylindrical-ovate, and hyaline. Müll.

Found in the water of dunghills. Very minute and pellucid.

**FUSUS.** Cylindrical, narrow, and truncated at both ends. Müll.

Observed only in pure water.

**EPISTOMIUM.** Elongated, cylindrical, with a fender fub-globular tip. Müll.

Inhabits putrid water. The body is round, obtufe behind, and its fize minute.

**SEMINULUM.** Cylindrical and equal. Müll.

In water kept fome days. The body twice the length of its breadth, pellucid before, and opaque behind. Moves by alternately afcending and defcending.

**NEBULOSA.** Oval-cylindrical, with vifible moveable intefines. Müll.

Found in waters with cyclidium glaucoma.

**FARCIMEN.** Cylindrical, curved, and truncated at both ends. Joblot.

In water kept a few days. Body opaque, and in its motion often appears in the fhape of the letter S.

**VIRIDIS.** Green, fub-cylindrical, and obliquely truncated before.

Abundant in water kept fome weeks. Tail obtufe, intefines obfcure.

**ENCHELUS,** *Εγκελος*, in *Ichthyology*, the name given by Aristotle, Appian, and all the Greek writers, to the eel.

**ENCHESON,** a French word ufed in our *Law-Books* and *Statutes*, fignifying the occafion, caufe, or reafon, wherefore any thing is done. Stat. 5 Edw. III. cap. 3.

**ENCHRISTA,** from *εγκρινω*, to *anoint*, in *Surgery*, liniments with which parts are anointed.

**ENCHYMA,** of *εγχυω*, *I pour in*, in the *Medical Writings of the Ancients*, a word ufed in feveral fenfes. Some have made it exprefs only an *infufion*; others have ufed it for what the modern phyficians call *plethora ad vafa*, that is, a fulnefs of the veffels, fimplly confidered, as a relative to themfelves; and others have made it the name of certain forms of liquid medicines, to be injected into the ears, into the thorax, or any other part.

**ENCHYMOMA,** of *εγχυμοσ*, from *εγχυω*, in the *Writings of the Ancient Phyficians*, a word ufed to exprefs that fudden effufion of blood into the cutaneous veffels, which arifes from joy, anger, fhame, or any other violent emotion of the mind, and is what we ufually call blufhing; which, according to Dr. Hunter, is a nervous affection.

**ENCHYMOMA** is alfo an afflux of the blood, whereby the external parts are rendered black and blue, as in the fcurvy, blood-hot eyes, &c.

**ENCHYMONITES,** in *Natural Hiftory*, the name of a kind of ftone found in Macedonia, and fome other places, which was alfo called *peonites* and *peanites*: it was fuppofed to be of great virtue to affift women in labour. See **CEANIDES**.

**ENCHYMO'SIS,** from *εγχυω*, to *pour into*, in *Surgery*, an extravafation of blood from the veffels, attended with black, blue, or livid appearance of the part. See **ECCHYMOSIS**.

**ENCHYSMA,** the fame with clyfter or enema.

**ENCHYTA,** in the *Medical Writings of the Ancients*,

a name given to fuch medicines as were injected into the eyes, or into any part.

Some alfo have ufed the fame word to exprefs a fort of funnel, contrived to convey the fumes of medicines to any part of the body.

**ENCKENDORP,** in *Geography*, a town of Germany, in the duchy of Holftain; 6 miles S.E. of Rendsburg.

**ENCKHUYSEN,** or **ENCKHUIZEN**, a confiderable town of Holland, on the Zuyder Zee, in North Holland; 9 miles N.E. of Horn, and 30 miles N.E. of Amfterdam. N. lat. 52° 40'. Its commerce, and particularly its herring-fifhery, was of great importance in former times; but its harbour is now almoft entirely choaked up with fand.

**ENCLAVE'**, in *Heraldry*, is where one thing is let into another, particularly where the jointure is fquare.

**ENCLITICA,** of *εγκλιτω*, *I incline*, in the *Greek and Latin Grammar*, certain particles, united fo clofely to the preceding word, that they only feem to form one word therewith; and the word which fufstains them does generally likewife bear the accent that governs them, efpecially when the enclitic is a monofyllable; as in *deminusque*, *κλιτω*; *τε*.

There are three enclitic particles in the Latin, *viz.* *que*, *ne*, and *ve*; but in the Greek many, as *τε*, *με*, *μοι*, *μι*, *σε*, *σοι*, *σν*, *πω*, *σπ*, *τε*, *γε*, *φημι*, *εμι*, *ποτι*, and others.

**ENCLOS, L'**, in *Biography*, a mufician in Louis XIII.th's band, an eminent performer on the lute and theorbo, or fingle and double lute.

He was father of the celebrated Ninon, who played on thefe inftruments as well as himfelf.

He dying in 1630, left her an orphan at 15 years old, beautiful, full of wit and talents, and formed to infpire the moft violent paffion. Nor did fhe wrap her talents in a napkin, but availed herfelf of all their influence; and even at more than fourfcore, fhe is faid to have awakened love in the learned abbé Gédoin.

It is pretended that cardinal Richelieu had her firft favours, and that he was the only one to whom fhe furrendered, without confulting her inclinations.

She was then 17, and it is certain that, ever after that time, fhe received a penfion of 2000 livres annually, which was long regularly paid.

Ninon gave concerts at her houfe, where perfons of the firft rank and talents came to admire her performance on the lute and harpfichord. The philofopher, Huyghens, the famous aftronomer, likewife obferved Ninon with great attention and accuracy, and even wrote verfes on her, which Voltaire calls *Geometric*.

“ She has inftruments five, which my brain much difturb,  
The two firft are her hands, the next are her eyes;  
But my tongue for the fifth and the beft I muft curb,  
Nor its beauties attempt to difclofe, if I'm wife.”

She was feldom left by her lovers, but fhe left them very foon; yet fhe always retained a friendship for her old admirers.

She was fo celebrated, that Chriftina queen of Sweden made her a vifit in 1654, in a fmall villa which fhe had in the neighbourhood of Paris.

Madame de Maintenon was her beft friend; and Voltaire afferts that M. de Villarecau was a lover in common with both, without its occafioning a quarrel.

He had two children by Ninon. The hiftory of the eldeft is known, who at 19 years old became paffionately enamoured of her; but on making the difcovery, he blew his brains out. Her fecond fon, called Boiffiere, died at

Rochelle in 1723, commissary of marine. She loved seriously for some time the marquis de Sévigné, brother of madame de Grignan; but who never wrote the letters to her, which M. d'Amouré has printed under her name about 40 years ago.

Madame de Maintenon, becoming all powerful, remembered her, and lent her word that she would take care of her fortune, if she would change her way of living, and think seriously of religion: Ninon replied, that she neither wanted fortune nor a mask. Ninon died at Paris, 1705, at the great age of 90.

ENCÆLIA, of *εν, in,* and *κοιλια, belly,* a word used by many of the ancient medical writers, to express the viscera contained in the abdomen, or lower belly.

ENCOLPIUM, or ENCOLPION, the pectoral cross of bishops, abbots, abesses, &c.; being one of the ordinary marks of the dignity of such persons both in the Latin and the Greek church.

ENCONDROS, of *εν, in,* and *χονδρος, grain,* in the *Old Greek Writers,* a word used to express any thing made up of a great number of small pieces, or flakes, or small grains of any thing. The manna of the ancients was not in large flakes, as we have it at present, but it was formed of a vast number of small granules, and was therefore called by Dioscorides, and some others of the Greeks, by this name. The word manna also signified with them the same thing; and they not only expressed the substance by it which we at present call so, but any other thing that was in small flakes, or pieces, was called manna. Thus the manna thuris, so much talked of among the old Greeks, was only a collection of those pieces which flew off from frankincense in the breaking. See MANNA *Libanotis.*

ENCOPE, of *εν,* and *κοπιω, I cut,* in *Surgery,* an incision of any part; as in a gangrene, &c.

ENCOUNTER, in a *Military Sense,* relates to that kind of deliberate attack, which is totally abstracted from accidental hostility, and may therefore be considered in contradistinction to the rencontre, which ordinarily implies a fortuitous meeting. Thus we find, "to lead troops to the encounter," is a very common expression; though we occasionally hear the term misapplied by persons who describe the losses, &c. sustained in accidental warfare, as having taken place, not in the rencontre, but in the encounter. We should also understand, that, in the strict sense, (which relates entirely to the arranging of troops opposite, that is, *en-contra,* to the enemy,) we ought not to consider circuitous attacks, and those feints made merely for the purpose of distracting the enemy's attention, as coming under this definition; and, on the other hand, we consider not only those who come into actual engagement, perhaps to the point of the bayonet, as is often the case in the attacks made by columns of infantry, but the supporting divisions also, to be engaged in the actual encounter. Thus we frequently perceive, that the leading regiment of a column is engaged, while the rear regiments bear no share in the contest; but if their situations be such as to expose them to the enemy's fire, they must be as much considered in the encounter as a vessel coming to the aid of another, so as to cause the enemy's ship to surrender, or to retreat. Hence it has ever been held a rule, that all vessels in fight, when a capture is made, become entitled to shares in the prize; because, on many occasions, the approach of reinforcements adds to the vigour of one party, while it depresses the spirits of the other, and influences it to decline further contest.

ENCRANIUM, in *Anatomy,* the same with cerebellum.

ENCRAVICOLUS, in *Ichthyology,* a species of clupea. See CLUPEA and ANCHOVY.

ENCRATITÆ, formed from *εγκρατις, continent,* in *Ecclesiastical History,* a sect of ancient heretics, thus called from their making profession of continence, and absolutely rejecting all use of marriage.

The founder of this sect was Tatian, a disciple of Justin, and one of the most learned persons of all antiquity. After the death of that martyr, he made a separation from the church, and soon had his followers; who, beside the dogma just mentioned, borrowed a great many things from Saturninius and Marcion; beside several errors, which they adhered to in common with the Gnostics and Valentinians.

They abstained from eating any thing that had life, and denied that Adam was saved. They looked on such as drank wine to be great sinners; and for this reason only made use of water in celebrating the Eucharist, as holding, that wine came from the devil. To countenance this tenet, they produced passages out of scripture, where mention is made of what befel Noah and Lot, when they were drunk.

They only admitted such of the books of the Old Testament as they thought good; but in lieu thereof, they owned several spurious and apocryphal writings for canonical and divine. Such were the Acts of St. Andrew, John, and Thomas.

ENCRAULOS, in *Ichthyology,* the name given by Aristotle, and many other of the ancient Greeks, to the fish which we call the anchovy. See CLUPEA and ANCHOVY.

ENCRINITES, in *Natural History,* a kind of columnar extraneous or organized fossil, found in the earth. See ENCRINUS, PENTACRINI, and ENTROCHI.

ENCRINUS FOSSIL, is the remains of an animal, so called by some; by others, this class of zoophytic remains is called *encrinites* (Parkinson's *Organic Remains,* vol. ii. p. 153.); and by others, denominated *entrochi,* or *pentacrini.* See those articles. See also Harenberg's *Encrinus* S. Liliun Lap. 4to.

ENCRINUS, a species of *Pennatula,* in the class of zoophyte worms, comprehending the cluster-polypi of Ellis, and inhabiting the Greenland sea.—Also, the name given by Ellis to the Ateria, a species of Isis, inhabiting the ocean that washes the coast of Barbadoes.

ENCRIS, in the *Medical Writings of the Ancients,* signifies a sort of cake made of fine flour, mixed with oil, and sweetened with honey.

ENCROACHMENT *of the Sea,* in *Geography,* signifies the sudden or gradual conversion of dry land into the verge of the ocean. History records numerous instances of great and devastating effects of this kind: some occasioned by the waves of the sea undermining the cliffs on its shore, and carrying away the matter thereof as fast as they fall, by which the boundaries of the sea have been considerably enlarged in some places; and its ravages still continue with increasing effect in some places, as on the chalky shores of Kent and Suffex. Another kind of marine encroachment, highly interesting to the geologist, is evidently taking place, by slow degrees, on a considerable portion of the flat shores of England; and can only be explained by an exceeding slow and gradual subsidence of the island itself, or a corresponding rise of the ocean which bounds it. This is particularly visible in the fens and marshes of our coast, which

which are now defended by banks of that magnitude and height, which scarcely any effort of the present day could at once effect; but which, as in the marshes embanked from the Thames below London, must have been begun centuries ago, when the tide flowed not so high by many feet as it does at present, and have been gradually raised, as the height of the water increased. The finding of immense fallen woods of trees, of the recent species, with the marks of human labour on them, and even the very tools by which they were felled, under great thickness of peat, the whole of which is now much below the level to which the tide rises twice each day, are also proofs of this general encroachment of the sea; since neither peat nor trees of any kind will grow where the salt-water of the ocean even saturates, much less continually overflows the ground. The mention of various instances of ancient and high embankments of marshes and fens against the tide, will be found under our article CANAL, in the divisions *Thames, Ouse, Welland, &c.* See also EMBANKMENT.

ENCROACHMENT. See INCROACHMENT, and AC-CROCHING.

ENCURECK, in *Natural History*, a venomous insect, found in Persia, and supposed by some to be a kind of tarantula. It neither stings nor bites, but lets fall its venom like a drop of water, which causes insufferable pain in the part for a time; and afterwards so profound a sleep, that we are told nothing can raise the patient from it but crushing one of those creatures on the part affected. It is nevertheless said, that the sheep eat these insects without damage. Olearius, ap. Boyle, Works abr. vol. i. p. 37. Ibid. p. 38.

ENCYCLOPÆDIA, the circle or chain of arts and sciences.

The word is compounded of the preposition *εν, in*, *κυκλος, circle*, and *παιδεια, science, doctrine, discipline, learning*; the root being *παις, child, infant*.

The Greeks used the term for the knowledge of the seven liberal arts, and the possession of all the sciences. *Orbis ille doctrinae, quem Græci εγκυκλοπαιδειαν vocant*, says Quintilian. It is sometimes also written *κυκλοπαιδεια, cyclopaedia*. Vitruvius, in the preface to his sixth book, calls it *encycliis disciplina*. See CYCLOPÆDIA.

ENCYSTED TUMOURS, in *Surgery*, swellings, which are formed of a bag, or cyst, which is filled with matter very various in its consistence and appearance. When the contents of the cyst resemble pap, the tumour is named *atheroma*; when they are of the consistence of honey and wax, it is called *meliceris*; when they are fatty, it is termed *steatoma*. See these words, and especially TUMOURS.

END for END, in the *Sea-Language*. When a rope runs all out of the block, so that it is unreeved, they say it is run out end for end.

The same phrase is applied to a cable that has wholly run out of the ship. In general, it denotes the reversal of the position of any object.

END-on is applied to a ship, which advances to a shore, rock, &c. without any apparent possibility of preventing her.

ENDE, in *Geography*, one of the smaller Molucca islands, S. lat. 8° 30'. E. long. 120°.

ENDEAVOUR RIVER, a river on the N. E. coast of New Holland, which at its mouth has a small bar harbour, or creek, that runs in a winding channel three or four leagues inland, and having at its head a small brook of fresh water. There is not depth of water for shipping above a mile within the bar. This part of the coast is fo

barricaded with shoals, as to make the harbour difficult of access, the safest approach to it being from the southward. S. lat 15° 26'. E. long. 215°.

ENDEAVOUR Straits, a channel or passage, so called by Cook, between New Guinea and New Holland, the N.E. entrance of which lies in S. lat. 10° 39'. W. long. 218° 36'. It is formed by the main, or the northern extremity of New Holland, on the S.E., and by a congeries of islands, which Cook called "the Prince of Wales's islands" to the N.W., which islands probably extend quite to New Guinea. The length of this channel from N.E. to S.W. is ten leagues, and it is about five leagues broad, except at the N.E. entrance, where it is somewhat less than two miles, being contracted by the islands which lie there. The depth of water in the strait is from four to nine fathom, with every where good anchorage, except upon the bank, which lies two leagues to the northward of Wallis's islands, where, at low water, the depth is only three fathom.

ENDECAGON, or HENDECAGON, in *Geometry*. See HENDECAGON.

ENDECASYLLABUS, or HENDECASYLLABUS. See HENDECASYLLABUS.

ENDECANDRIA, in *Botany*, from *ενδεκα, eleven*, and *ανηρ, a man*, an order of the Linnæan class *Monadelpbia*, characterized by having eleven stamens, whose filaments are, as the character of the class itself requires, united into a tube. It contains only the genus *Brounea*, the number of whose stamens is different in different species, and this precise number of eleven is so unusual, and apparently unnatural, in flowers where five and ten so much predominate, that perhaps the order in question might be, without mischief, abolished.

ENDECERES, of *ενδεκα, eleven*, in the *Naval Architecture of the Ancients*, a word used to express a galley which had eleven series or tires of rowers. Those with two or three tires were very much in use among the ancients, and from those to such as had five or six tires. Those of nine tires were sometimes used, but it was very seldom; and those of eleven, fifteen, and so on, were rather for state, than service. We read of them carried so high as to contain twenty, thirty, and forty rows of oars. One of this largest sort was built for Philopater, which required four thousand men.

ENDEIXIS, *Ενδειξις*, in *Antiquity*, an action brought against such as affected any place or thing, of which they were incapable by law. Pott. Archæol. Græc. lib. i. cap. 23. tom. i. p. 125.

ENDELAVE, in *Geography*, a small island of Denmark; eight miles N. of Funen.

ENDEMIC, or ENDEMIAL, *Diseases*, from *εν, in*, and *δημος, a nation, or people*, are those diseases which occur among the inhabitants of a particular region or place, in consequence of certain circumstances belonging to it, and not arising from contagion, or any other general cause.

Thus agues, or intermittent and remittent fevers, which are occasioned by the miasms of marshy ground, are endemic in low countries: the *goitre*, or bronchocele, connected with that peculiar intellectual imbecility, which characterizes the CRETIN, is endemic among the Alps, where its origin has been erroneously ascribed to the use of snow-water: the colic, *COLICA Pisonum*, is endemic in the cyder-counties, especially in Devonshire: the bilious remittent fever, or yellow fever, is endemic in the West India islands; and so forth. In all these instances, some local cause obviously exists, which produces the disease in the respective districts, the disease belongs to the districts, therefore, and affects those who reside there, but extends no farther. Whereas

an epidemic disease is produced, or at least propagated among the people, in consequence of some general cause; as contagion, famine, or, perhaps, some change in the condition of the atmosphere at large.

Hence the distinction between endemic and epidemic diseases is obviously of great importance, for, in both cases, much more beneficial purposes may be accomplished in the way of prevention, than in that of cure. But the prevention of diseases depends altogether upon a knowledge of their causes, which should therefore be accurately investigated, whenever they prevail extensively. If a disease is endemic, *i. e.* originates in some local cause, (from marsh effluvia, for instance;) it may attack the same person again and again, while he remains in the same situation; but he infallibly escapes it by removing his residence; or the inhabitants of the district may be all defended from its attacks by draining the marshy ground, whence the miasmata issue. Thus we are told by writers on the diseases of armies, that the disorders which arise from the foul ground of camps, are readily made to disappear by removing but a few hundred yards from the situation which they previously occupied. And of the beneficial effects of attention to the local causes of endemic diseases, we have a striking example in the changes, which have occurred in London, in respect to the diseases of its inhabitants. In the time of Sydenham and Morton, *viz.* in the latter half of the seventeenth century, remittent and intermittent fevers were generally prevalent to a great extent, in the autumnal season, and were often extremely fatal to the inhabitants of the metropolis; and the bills of mortality shew, that formerly the dysentery, which almost constantly appears in the same places and seasons as the remittent fever, was annually fatal to great numbers. But of late years these diseases have almost entirely disappeared; intermittents occurring only occasionally after wet seasons, in those people who have visited the fenny counties during the harvest; and dysentery sometimes prevailing, in a mild way, in those seasons only when the heat has been unusually great. This exemption, which London now enjoys from those endemic diseases, is chiefly to be ascribed to the improvements that have been made in the pavement, drains, and sewers, and the attention that is paid to cleaning and supplying with water the several parts of the town. In some towns where these precautions are neglected, the remittent fever is still found at times to commit great ravages. It is probable that the fever, which proved so fatal in Philadelphia, in the year 1793, was of this kind, and produced from the causes just mentioned. (See Rush's Observations on the Fever of Philad. 1799. Dr. Miller's Report, New York, 1806.)

Some writers confine the term *endemic* to those diseases which are constantly present in certain districts, at all times and seasons, such as the *goutre* of the Alps; and call those *epidemic*, which are the product of certain seasons, although originating in a local cause, as the autumnal intermittent and remittent fevers of fenny and hot countries. See EPIDEMIC.

ENDENA, in *Geography*, a town of Italy, in the Bergamasco; seven miles N. of Bergamo.

ENDEDENTED, DENTED, or *Indented*, in *Heraldry*. See INDENTED.

ENDEDENTED is also applied to a fess or pale, and other triangular pieces, when divided alternately between two different colours. Coupé, or endedent with or and azure.

ENDER, in *Geography*, a town of Italy, in the Bergamasco; 12 miles N.E. of Bergamo.—Also, a river of Scotland, which runs into the Garry, seven miles W. of Blair Athol, in Perthshire.

ENDERSTORF, a town of Silesia, in the principality

of Neysze; 3½ miles, S. of Ziegenhals.—Also, a town in the same country and principality; 3½ miles S.W. of Grotkau.

ENDESIS, from *en* and *des*, *I lind*, a word used by Hippocrates to express that part of the foot where the bones of the tibia end, and which is connected by ligaments to the ankle.

ENDEW, in *Falconry*, is said of a hawk that digests her meat so well, that she not only discharges her gorge of it, but even cleanses her pannel.

ENDIAN, in *Geography*, a town of Persia in the province of Chusistan; 150 miles S.S.E. of Susa.

ENDICA, a word used by the alchemists for the fæces which subside to the bottom of the vessels in infusions: to some of which they attribute great virtues.

END-JOINTS, in *Mining*, otherwise called *cutters*, in coal-mining, are the shorter of the natural joints or upright partings of any measure or stratum; the longer of these joints being called *Backs*, *Slines*, face or lengthway-joints, or partings: for it seldom happens in any quarry or work, that the face-joints are not much longer than the end or cross-joints.

ENDINGEN, in *Geography*, a town of Germany, in Austrian Swabia; seven miles N.W. of Fribourg.

ENDINGS OF STRATA, in *Geology*, signify the edges of the strata, in their greatest advance towards the north west, or in the direction of their general *rise*, according to the observations of Mr. William Smith and his followers; by whom it has been observed, in all the eastern parts of England, that the strata *end* successively towards the N.W. generally with a fingered or digitated outline, in some, in places running out for miles in ridges, beyond the general range of the edge or limit of the stratum: the more recent observations in Derbyshire, at Chelmsleton-low, for instance, and other projecting points of strata in that *denudated* district, shew, however, the necessity of a careful attention to the fingered or projecting points of strata, and to other concurrent circumstances, before such fingerings alone are admitted as proofs of the ending of a stratum, rather than as part of the edge of a denudated tract, on the opposite side of which the same stratum is to be found again, either on the surface, or abruptly sunk beneath it by a fault, and upper measures occupy that surface. See DENUDATION, and CONCENTRICITY of Strata.

ENDITEMENT, or INDICTMENT, in *Common Law*. See INDICTMENT.

ENDIVE, in *Gardening*, the common name of an esculent plant which is well known in garden culture. There are different varieties of it, but that which is perfectly curled, is the most useful for culinary purposes. See CICHORIUM.

ENDIVIA, in *Botany*, *Cichorium Endivia* of Linnæus, the garden endive. Ambrosini derives the word from *edendo*, eating, because the plant is so grateful to the palate. It appears to us rather a corruption of one of its old names *Entyba*, or *Intuba*.

ENDIVIA MARINA, the *sea-endive*, in *Natural History*, the name of a species of sea plant, or marine substance, described by count Marsigli. There are two species of it, the one having broad and jagged leaves, resembling those of the vine, the other much narrower. This last kind grows on stones, shells, pieces of wood, or any other substances, accidentally found at the bottom of the sea. It seldom grows in very deep water, and thrives best in places where the sea is calm and quiet. It is of a dusky greenish colour, variegated in some places with yellow. It exactly resembles the shape of the endive common in our gardens, and its leaves are cut and fringed in the same manner; but

but they are of so tender a substance, that a slight touch destroys them; they are indeed tenderer and more delicate than those of any other known plant, either of the sea or land. When this substance is examined by the microscope, its surface is found to be composed of a great number of eminences and cavities, or little holes, between and among them; and when the leaves are cut transversely, there are seen a great number of glandules in them. Marfigli, *Hist. de la Mer*, p. 72. See CORALLINES.

ENDLESS ROLLS, and *Sereze*. See the Substantives.

ENDOCARPON, in *Botany*, from *ενδοσ*, *within*, and *καρπος*, *fruit*, alluding to the receptacle of the seeds being deeply imbedded in the substance of the leaf, or rather frond. Hedw. *Crypt. v. 2. 56. t. 20. f. A. Ach. Prod. 140. Meth. 125.* (Lichen; Zoega Island. 15. Dicks. *Crypt. fasc. 2. 22. With. v. 4. 52. Sm. Engl. Bot. v. 9. 595, &c.*) Class and order, *Cryptogamia Algæ. Nat. Ord. Lichenes.*

Gen. Ch. Frond cartilaginous, rigid, rounded, peltate, depressed; naked beneath. Receptacles immersed in the substance of the frond, globose; their edges a little protuberant; their concave disk lodging the seeds in vertical cells, and at length expanded and displayed.

Ess. Ch. Receptacles immersed, globose, concave, in which the seeds are imbedded.

This genus is, perhaps, more judiciously than most separated from the great genus or family of *Lichen*, by Hedwig, followed by the accurate Dr. Acharius. The only question is whether *Verrucaria* ought not to be joined with it, as differing not at all in the parts of fructification, though its frond is a crust instead of a leaf, just as his various *Parmelia* differ, even more widely, among themselves. Several species of *Endocarpion* are figured in *Engl. Bot. t. 593—595. 1512. 1698. 1866. 2012, and 2013.* They are small roundish or angular plants, commonly growing closely pressed to the earth or stone, of a grey or olive hue, their fructification appearing like little black dots over the surface.

ENDOR, in *Ancient Geography*, a town of Judea, in the half-tribe of Manasseh, on this side Jordan, according to the book of Joshua. Eusebius places it four miles S. from mount Tabor, near Naim, in the way to Scythopolis.

ENDOR, *Witch of*. See WITCH of Endor.

ENDORSE, in *Heraldry*, an ordinary, containing the eighth part of a pale.

This, Leigh says, is never used but when a pale is between two fuch: though others hold, that an endorse may be borne between birds, fishes, beasts, &c. Sir J. Ferne adds, that it shews the same coat has been sometimes two coats, and afterwards conjoined within one escutcheon, for some mystery of arms. He bears azure an endorse argent.

ENDORSED, ENDOSSE', is where things are borne back to back.

ENDORSEMENT, of *in* and *dorsum*, *back*, is particularly used, in *Commerce*, for a writing on the back of a bill of exchange by the proprietor or bearer, either thereby to transfer it to some other, or to render it payable to the order of some other, or else to serve for an acquittance or receipt. See EXCHANGE.

The endorsement is only the name of the proprietor, or endorser. Note, when the endorsement of a bill of exchange is to render it payable to another, it is called an *order*.

To an order it is necessary the endorsement be dated; and contain the name of him who paid the value thereof; in which case, the bill belongs to the person with whose

name the order is filed, without any other tradition: without these conditions, the bill is judged to belong to the person who endorsed it. The bearer of a bill of exchange protested has a remedy against the endorsers for the payment of the re-change of the places where the bill was negotiated by their order. In case a bill or note is refused to be paid, &c. the bearer has a remedy against any one of the endorsers, where there are several. See BILL.

ENDORRING, or INDORSING, in *Law*, implies the writing on the back side of a deed, instrument, &c. something relating to the matters contained therein.

ENDOSIS, *Endosis*, of *εν* and *διδωμι*, *I give*, in the *Medical Writings of the Ancients*, a word used to express a remission of any kind, as when a tumour, inflammation, or hardness of any part, becomes less violent; and when the patient becomes easier, after the exacerbations in fevers of the continual kind, and after fits of the intermittent.

ENDOWMENT, or INDOWMENT, the giving or assigning of a dower to a woman. See DOWER.

The word is also used figuratively, for the setting forth or serving a sufficient portion for a vicar, towards his perpetual maintenance, when the benefice is appropriated; whence such a vicarage is called a vicarage endowed.

ENDRACHIUM, in *Botany*, *Juss. 133*, see THOUINIA. The name is barbarous, corrupted from the Madagascar word *Endrach*, under which it occurs in *Lamarck's Encycl. v. 2. 356*, who nevertheless calls the genus *Humbertia*, following *Commerçon*. See *Lamarck's plates, t. 103*. Dr. Smith named it *Thouinia*, and is followed by *Schreber, Willdenow, and Martyn*.

ENDRAPA, in *Ancient Geography*, a town of Asia, in Mesopotamia, situated on the left bank of the Euphrates.

ENDSCHUTZ, in *Geography*, a town of Germany, in the circle of Upper Saxony, and circle of Neustadt; 4 miles E.N.E. of Weyda.

ENDYMATIA, in *Antiquity*, a kind of dance used among the Greeks, performed in Arcadia, to the sound of certain airs composed for the flute.

ENEDA, in *Geography*, a town of Switzerland; in the canton of Glaris; 2 miles E. of Glaris.

ENELIAXIS, *Ενελιαξίς*, or rather *Enyalixis*, *Ενυαλιξις*, in *Antiquity*, a festival in honour of Enyalus, whom some will have to be the same with Mars, others only one of his ministers. *Pott. Archæol. Græc. lib. ii. cap. 20. tom. i. p. 394.*

ENEMA, of *ενεμα*, *I put in*, in *Medicine*, denotes a clyster. See CLYSTER.

ENEMY. See ALIEN.

ENEOREMA, of *εναιρω*, *I lift up*, is used by ancient medical writers for those parts of the urine which float about in the middle resembling a cloud, formed, according to Boerhaave, principally of muriatic salt. *Comm. Initit. § 382.*

ENEOS, of *εν* and *ωσς*, *I cry*, a word used by the ancient writers in *Medicine*, for a person born deaf, or unable to perform the common offices of life, for want of any of the principal organs.

ENERGETICAL BODIES or *Particles*, are such as are eminently active, and which produce manifest operations of various natures, according to the various circumstances and motions of such bodies or particles.

ENERGICI, in *Ecclésiastical History*, an appellation given to certain disciples of Calvin and Melancthon, of the sixteenth century, because they held the Eucharist was the energy and virtue of Jesus Christ; not his real body, nor a representation thereof.

ENERGUMENUS, *Ενεργουμενος*, a term sometimes used

by divines and schoolmen, to signify a person possessed with a devil, or an evil spirit.

The word is formed from the Greek, *εργασιας*, to be agitated, worked, of *ερ*, and *εργον*, *opus*.

Though Papias says, the Energumeni were such as counterfeited the actions of the devil, performing things which seemed supernatural. The council of Orange debars, or deprives the Energumeni of the functions of the priesthood. See DEMONIAC.

ENERGY, in *Elocution*, a mode of delivery applicable to particular passages of a discourse that are meant to be rendered particularly impressive and operative upon the feelings and convictions; like emotion, if not too frequently appealed to, or too extravagantly exerted, it has a great tendency to demonstrate the sincerity and real earnestness of the speaker; which is always one of the indispensable requisites for the conviction of the hearer. In declamation it should be manifested alike in the enunciation, the tones of the voice (which should be firm and fervid), and in the gesticulation. It is this quality in the speaker that seems to have been designated by Demosthenes as the first, second, and third requisite of an orator. *Actio* (*Ενεργεια*, the Latin *actio*;) not being confined in signification to the mere motion of the limbs, but to the entire and reciprocal exertion of the mental and organic faculties of the speaker, the co-operative energy of thought, language, enunciation, tone, look, gesture, and deportment. "Et actio oratoris pronuntiatio ac gestus, & ipsa adeo administratio causæ." Cic. in Orat. c. 17. "Oratorical action is pronuntiatio and gesture; hence the very delivery of the subject." "Est actio quasi corporis quædam eloquentia, cum constet e voce et motu." Quintil. Q. 3. "Action is, as it were, a certain eloquence of the body, consisting in voice and motion." See also Gesner's *Thesaurus* in voc. *actio*.

ENERGY, in *Painting* or *Sculpture*, may be divided into two parts, *viz.* energy of thought, and energy of execution.

The former consists in deeply investigating the nature and interest of a subject, and selecting that most impressive and decisive moment for representation (and also the mode of doing it) which shall convey to the imagination of the beholder with the greatest interest, either its history or its moral.

The latter consists in that same active, animated spirit, being accompanied by the power of displaying the representation of that selection, either on marble or on canvas, with force, with freedom, and precision; without labouring, at least without leaving the appearance of labour, in endeavouring to obtain its expression.

The comparison of two artists who in their works have each respectively exhibited the possession of these two qualities in the highest degree, will best illustrate our meaning.

Raphael's works are full of energy of thought. Those of Titoretto of energy of execution.

The former always fixes upon that precise moment of time in a story which is most favourable for relating it with success; and is sure to interest by the force and truth with which he unfolds the circumstances of it. He sometimes even, and that with the greatest propriety, goes farther than the mere relation of the particular subject; he accompanies and illustrates it by allusions to antecedent and subsequent events connected with it; as in the cartoon of the death of Ananias.

In that picture, some of the disciples on the right of St. Peter are still engaged in distributing alms, not yet having observed the instantaneous punishment inflicted by Almighty vengeance on the guilty sinner; we are thus unaffectedly

informed of the object for which the apostles are assembled, and how they were engaged previously to the time of the immediate subject of the work, and we are led as simply to understand somewhat of that which followed, by the introduction of the figure of Sapphira; who advances on the opposite side, intent upon counting the money she may be supposed proposing either to give to the fund devoted to charity, or to withhold, that she might gratify her own, and her now dying husband's avarice; whose fate, of which she appears to be altogether unapprized, so nearly awaited herself, for her design of committing the crime for which he was so awfully punished.

Thus we see, that no part of the interest of the subject escaped the active energy of the mind of Raphael, and many others of his works would as well illustrate his great ability in this point of the art; *e. g.* the cartoon of St. Paul preaching at Athens, but in neither of these noble works is there much energy of execution: that was the forte of Tintoretto.

He seldom stopped to think correctly and refinedly upon his subject. He rarely portrays the passions with truth in the countenances of his figures, or gives his story interest on the mind; except by the astonishing freedom, force, and fire of his pencil in the execution, where it appears to have moved with the utmost rapidity; the canvas trembles under it. His vigour in colour equals the skill of his workmanship; and these united, the observer forgets the want of more valuable beauties. The skill of the matter strikes more than the work itself. His execution well deserves the appellation bestowed upon it by the Carracci, "Il terribile maniera del Tintoretto." It still remains a desideratum in art to see it united with elegance of design; with feeling, and truth in thought, and expression.

In sculpture the author of the Laocoon has effected their union. We may, therefore, hope its sister art may sometime arrive at an equal degree of perfection. But there are so many more points of difficulty to overcome in painting than in sculpture, that he must be almost super-human who effects it.

Many will rather wish that Michael Angelo had been instanced as possessing energy of thought in preference to Raphael; and justly he might have been hailed as a wonderful model of it, as he also was to a considerable degree in the other acceptation of the word, *viz.* in execution. But his energy is less understood than that of Raphael; and is of a less valuable kind; as it not infrequently renders his figures enigmatic, and nature is lost in art. Raphael comes equally with him, home to his subject; and can scarcely ever be misunderstood. Hence, therefore, we think ourselves justified in presenting the latter to the attention of our readers rather than the former; not as willing to depreciate Michael Angelo; but because we conceive, that while the consideration of his energetic powers may invigorate the student, it may divert his mind from truth, and lead him to bombast and affectation; which the contemplation of the works of Raphael never can do, unless he be of a most perverse stamp of nature indeed. If energy of thought may be said to be characterized by those strong workings of the imagination alone, which produce the representation of the most extraordinary and powerful actions of the human body, with bold fore-shortenings and strong expressions; then M. Angelo claims by far the highest place, but we do not conceive that to be the best criterion for judgment on this point. He who sees clearest, and while he gives it powerfully, most justly and beautifully illustrates his subject, must surely have as fully and warmly conceived the nature of it; as he, who, mixing the extravagance of enthusiasm with his energies, permits his mind to run wild upon it; and throws upon his

canvas figures which rather confuse than exemplify, and draw the attention of the observer from the subject to the painter. This enthusiasm, we think, does characterize in a great measure the wonderful works of M. Angelo; whilst Raphael's mind, though full of energy, is pure, and going to the extreme of indulgence in his subject, still keeps within its bounds.

**ENERVATING**, the act of destroying the force, use, or office of the nerves, either by cutting them, by weakening them with debauchery, or by some other violence.

Excess of wine, and other strong, hot, spirituous liquors, enervate or weaken the nerves. When they would render a horse useless, they enervate him, or cut his nerves.

**ENERVATING**, is particularly used in the *Manege*, for the cutting two tendons on the side of a horse's head, under the eyes, which meet on the tip of the nose; they thus enervate horses, to make their heads small and lean.

The word is also used figuratively. It is no small artifice in disputing, to be able to enervate and extenuate the allegations of one's antagonist. This author has a weak enervate style. See **NERVE**.

**ENERVATION**, a term in the *Ancient Anatomy*, applied to the tendons of the recti, or straight muscles of the abdomen.

The fibres of the recti of the abdomen do not go from one extreme of the muscles to the other, but are intersected by several nervous places, called by the ancients enervations, though they be real tendons.

Their number is not alike in all; some having three, others four, &c.

**NERVE, FOLIUM**, in *Botany*, a leaf destitute of ribs and nerves. See **LEAF**, and **COSTATUM FOLIUM**.

**ENFANS PERDUS**, a French phrase, used in war to signify the soldiers who march at the head of a body of forces appointed to sustain them, in order to begin an attack; make an assault, or force a post.

The word literally imports *lost children*, on account of the imminent danger they are exposed to.

In English, they are called the *forlorn*, or *forlorn hope*.

At present, the grenadiers usually begin such attacks.

**ENFIELD, WILLIAM**, in *Biography*, was born at Sudbury in the year 1741, and educated for the ministry among the Protestant dissenters at the academy at Daventry, where he distinguished himself by the polish of his early compositions. He was first settled as minister with the congregation at Benn's garden, Liverpool; this was in the year 1763; and, in 1770, he became resident tutor and lecturer in the belles-lettres in the academy at Warrington. He shortly after qualified himself as mathematical tutor, and in that character published "The Institutes of Natural Philosophy," in quarto. A new edition of this work was published after the doctor's death, with considerable additions, and an introduction to the modern doctrines and discoveries in chemistry. It may be reckoned one of the best popular introductions to Natural and Experimental philosophy. During his labours at Warrington, which were highly prized, the university of Edinburgh conferred upon him the title of doctor of laws. In the year 1785, he removed to Norwich, and became pastor of the congregation of dissenters in that place. With the duties of this office, he successfully employed himself in various literary undertakings, among which was the laborious task of translating and abridging "Brucker's History of Philosophy," a work to which we have frequent occasion to refer in the course of our own investigations of the learning of ancient times. This abridgment was published in two vols. 4to. in 1791,

and "probably," says his friend and biographer, Dr. Aikin, "the tenets of the different sects of philosophers were never before displayed with so much elegance and perspicuity. It was, indeed, his peculiar talent to express the ideas of other men to the greatest advantage. His language, chaste, clear, correct, and free from all affectation, is one of the best specimens of that middle style which is fitted for all topics, and he communicates to his reader all that clearness of idea which reigned in his own mind. These qualities, together with the candour and moderation which made part of his very constitution, especially fitted him for the office of literary criticism, and he was long an associate in one of the most respectable of the periodical journals." He died November 3d, 1797, in the 57th year of his age, generally beloved and lamented. In every relation of life, the benevolence of a kind heart displayed itself in the most engaging features. He published "Sermons," "Family Prayers," and "The Preacher's Directory." His compilations, entitled "The Speaker," and "Exercises in Elocution," are perhaps the most popular works in our language, and they unquestionably merit the patronage which they have had, and continue to have. After his death three volumes of his sermons were published by subscription, and the numerous friends who patronized this work, will prove the attachment which he had inspired. Gen. Biog.

**ENFIELD**, in *Geography*, a town and parish in the hundred of Edmonton, and county of Middlesex, England, is situated nine miles from London, and contained, according to the late return to parliament, 926 houses, inhabited by 5881 persons.

It is styled in ancient records Ensen, or Insen, from its fenny soil, which is now, however, converted into good land, by draining, &c. The parish is very extensive, the town itself being but a small part of what bears the name of Enfield. The parish church is an ancient structure, and has been recently repaired. Here are a good free school, and two meeting-houses for dissenters. Part of an ancient royal palace still remains, where Edward VI. is said to have resided, and where queen Elizabeth kept her court in the early part of her reign. One of the rooms appears in its original state, with oak panels, and a richly ornamented ceiling: the chimney-piece is of admirable workmanship, and decorated with the arms of England and France quartered. The palace was alienated from the crown by Charles I. and has ever since been private property. In 1670 it was taken by Mr. Uvedale, master of the grammar-school, who, being attached to botanical studies, planted in the garden a cedar of Libanus, which, in 1793, measured twelve feet in girth, three from the ground. The town had formerly a good market, which is fallen into disuse. In the suburbs are a number of boarding-schools, and several elegant villas. Enfield was heretofore much celebrated for its *Chase*, which comprized a large tract of woodland, well stocked with deer; but during the civil war it was stripped both of game and timber, and let out into small farms: after the restoration it was again laid open, woods planted, and filled with deer. In 1779 it was disafforested by act of parliament; parcels were allotted to different parishes, and the remainder sold. A part was bought by Dr. Jebb, who having successfully attended the duke of Gloucester at Trent, the king, on conferring the dignity of baronet on him, gave the name of Trent-place to the villa which he had erected here. South Lodge, also on the chase, was the favourite retirement of the late earl of Chatham. East Lodge was the hunting seat of Charles I.

In this parish, at a place called "Four-tree hill," or Forty-hill, the late Richard Gough, esq. had a seat, where

where he died; in February 1809. Some account of this eminent topographer and antiquary will be given in a subsequent part of this work. Lyson's Environs of London, vol. ii.

ENFIELD, a township of America, in Hartford county, Connecticut, on the east bank of Connecticut river, opposite to Suffield, and bounded on the north by the Massachusetts line; settled in 1681. In 1769 it contained 214 English families. In the town are two congregational churches, and a meeting-house for the sect called Shakers. The town is pleasant, and contains 1761 inhabitants; 18 miles N. of Hartford.—Also, a township in Grafton county, New Hampshire, about 11 miles S.E. of Dartmouth college; incorporated in 1761, and containing 1121 inhabitants.

ENFILADE, a French term, sometimes used in English, signifying a series or continuation of several things, disposed, as it were, in the same thread or line; as an enfilade of rooms, of doors, of buildings, &c.

The word is formed of the French verb, *enfiler*, to string a thing, which is compounded of *en*, *in*, and *fil*, of *filum*, thread; *q. d.* a thread or string of any thing.

ENFILADE, in *Military Matters*, relates to a certain mode of acting upon the defenders of lines, redoubts, batteries, &c. thereby counteracting the impediments thrown in the way of a direct fire. To explain this, it is necessary to observe, that defences may be attacked in three modes; *viz.* *direct*, that is, by a responsive fire in front, or, at least, so little obliqued as to come under the general acceptance of what the French engineers term *siyant*, or, plunging; this fire is commonly at right angles with the line of defence to be battered: when the fire is much obliqued, it is said to be *razant*, or grazing. The second mode of attack is by *reverse*; that is, where the batteries of the besiegers can be so directed as to command the interior of the rampart, and thus render it impossible for the defenders to remain at their guns. This mode generally relates to an angle of at least fifteen degrees from the line of the defence in question, but may extend to any angle up to 90°; remarking, however, that the more direct the fire may be in reverse, the less execution will be done, because the shot can only strike one particular object. The third mode is by *enfilade*, and is always the most destructive, especially if the guns of the enfilading battery can be brought to bear at a right angle with the direction of the battery to be enfiladed. When this cannot be effected, it is necessary to make a small angle in reverse, the less the better, thereby to throw the shots along the interior of the parapets, and to take the whole in flank. Some fortresses are unavoidably so situated as to have one, or perhaps two batteries exposed to a very distant enfilade. Such a defect is of the utmost importance, and cannot be radically overcome; for we sometimes see some hill, or what is worse, some shifting sand, which cannot possibly be either removed or occupied, but which affords both a command, and a lodgment in security from the fire of the place. Although this is assuredly an immense drawback on the strength of the works, it is nevertheless in some situations of little moment; for instance, where it is necessary to retain a small force for the purpose only of preventing an enemy from landing at the only accessible spot upon a long range of coast, presenting in every other part such natural obstacles as annihilate all apprehensions of invasion. In such place the surrounding eminences are of no moment; or if they were, must rather be considered as offering advantages, and the means of rendering the place untenable to the enemy, should they succeed in carrying the works.

Speaking generally, however, a fortress that can be en-

filaded with tolerable safety to the besiegers must be untenable; because it is impossible to devise effectual means for remedying the evil. It is true, we may raise large epaulements, or batteries of soil, masonry, &c. for the purpose of preventing the enemy's shot from ranging along the rampart; but, in most instances, where enfilades can be made, these epaulements would require to be carried to such an immense height, as must, in a measure, deteriorate the other defences; in some instances rendering them nugatory, or even advantageous to the assailants, whenever they may be able to make a lodgment. Besides, such epaulements are very liable to be destroyed by mortar and howitzer batteries, or by mines. This mode of parrying the enfilade has, with much propriety, been of late years designated by the French engineers a *defilade*, a term peculiarly expressive of the intention of whatever devices may be used for the purpose of preventing defences from being enfiladed. It must not be forgot, that the approaches of besiegers should be carefully constructed; else they may be subjected to enfilade from some of the defences. That evils, however, easily avoided; and if, through ignorance or inadvertence, found to take place, may be instantly corrected, as the besiegers have, on almost all occasions, ample range for alteration, and can adopt a variety of measures totally unattainable to those within the fortrefs.

Where a work is carried over a rising ground, it is generally very difficult to render the interior of the batteries safe from either reverse or enfilade. The best mode is to carry them up the ascent *en escalier*, that is, by short levels, each perhaps capable of mounting four or five guns, and every such level being cut off from its neighbour below, by a heavy epaulement, carried up high enough to prevent the besiegers from trundling their shots along within the parapet. The most effectual method of cutting off enfilades is to give the rampart such an augmentation of thickness as may allow a free passage for cannon, &c. along the rear of those in the embrasures, and to fill up the spaces between the latter with *traverfes*, carried to at least ten feet in height. These traverfes are nothing more than regular masses of soil, properly turfed, or perhaps reveted with masonry, placed at right angles with the parapet, and uniting therewith: their thickness ought not to be less than ten feet.

We must here observe, that with few exceptions, the enfilade commonly takes place from the exterior flank of the battery; therefore that quarter should be chiefly attended to. With this view it is found most proper to construct each traverse partly of masonry, and partly of soil well gazoned, (*i. e.* turfed) or, if on emergency, firmly retained by fascines. Sometimes sand bags will be found to answer for this part, when the residue of the thickness is completed with good masonry, at least four feet in substance. Where cotton, or wool, or raw hides, are procurable, they will be found to make admirable traverfes, if sustained by a firm wall: these being placed nearest to the enfilading quarter, will, by their elasticity, completely deaden the force of the shot, however great their calibres, and cause them, if they should reach so far, to be weak and insignificant in their impression upon the interior buttress of masonry. It should seem, to persons unacquainted with the practice of defending places, that, in consequence of the great resistance offered by solid masonry to cannon-shot, which will often bury themselves full fifteen feet, or more, in ordinary soil, the traverfes should be constructed of masonry only: this would, no doubt, present great firmness in a contracted space; but the inconceivable destruction and dismay occasioned by the splinters knocked off by shots that strike upon bricks or stones, opposes an insuperable bar to what would otherwise prove a

most valuable mode of construction; such, indeed, as would render many places absolutely impregnable. This compels us to resort to such materials as are, in a great measure, devoid of such mischiefs, of which turf is the best.

It is generally considered, that the enfilade is cut off by placing traverses at from fifteen to twenty toises asunder; but the latter distance, (equal to forty yards,) is certainly too great: it would even be advisable to bed the guns between traverses, as we have above shewn, were it not that by so doing the battery must be weakened, owing to the spaces occupied by so many buttresses. However, necessity and, generally speaking, locality, must give laws for the construction of such impediments to the enfilades. It must be understood, that the obnoxious battery may be very powerful; that is, it may not only mount heavy cannon, but may be far more numerous than might at first be supposed. To explain this, it must be stated that the most destructive enfilade is that which ranges along the interior of a battery, at about from two to six feet within the parapet; since in that direction it is sure to destroy not only the defenders, but even the cannon, dismounting them, and crushing the gunners, as well as causing a variety of splinters to scatter among them, from the several parts of the wood and iron work. Sometimes, indeed, when the shots touch upon the cannons themselves, the former, being of cast iron, and consequently liable to shiver when forcibly struck, break into numerous pieces, or even fracture the latter, so as to render them perfectly unserviceable.

If shots were to be fired at such an elevation as barely to graze the crest, or summit, of the parapet, they would certainly prove most destructive to the defence flanked by such a forcible fire; but this cannot be effected at short distances, since, it is evident, the shots would, at the moment of touching the crest of the parapet, be *ascending*, and that too with such force as could not fail to impel them far over every part of the fortrefs, and thus to prove completely unavailing. This mode of enfilade, therefore, commonly takes place where the cannon is not at least on a level with the crest of the parapet, so as to send its shot through it with sufficient force to cut clean through, without being thrown upwards into a new direction, and thus to plunge into the more remote part of the defence. When the enfilade is more distantly situated, the shots may certainly be thrown over the parapet as they are *descending* upon their long range; but this is very uncertain, and rarely does much execution; to be sure, when the shots can be correctly thrown, the havoc they create is dreadful.

The usual mode of enfilading is by ricochet, that is, by giving the piece, whether mortar, howitzer, or cannon, such an elevation, and such a charge, as may cause the shot to bound first on the glacis, and then over the rampart into the battery. This, our readers will perceive, is exactly on the principle of "a three-quarter ball" at cricket; which, if it passes over the wicket, makes several low bounds, or, as they are technically termed, "lobs," in proceeding along their course, until they come to a state of rest. So does a cannon-shot, after bounding over a rampart, keep lobbing, rather more forcibly indeed than a cricket-ball, along the terre pleine of the rampart. It will not be necessary to expatiate on the effects of this dreadful contrivance, they being so obvious, and so completely similar to what is called "raking fore and aft," in naval warfare.

The most powerful ricochet takes place at an angle under ten degrees of elevation; fifteen degrees are the utmost that are allowed, both because the effect produced is less when the elevation is encreased, and the gun-carriage is proportionally injured by the direction of the recoil deviating from

the horizontal, so as to depress and strain the hinder parts of the frame work; while, at the same time, the wheels are lifted in the fore part, and return to the ground with undue force. When mortars are used in ricochet firing, they are commonly charged with a number of shots, or of shells, forming in the whole, what we may term, a round of grape proportioned to the calibre of the piece. In batteries intended solely for ricochet firing, the embrasures should have their superior slope outwards, as seen at K in the plate; whereby the enemy could not fire into it so easily as if the embrasures were made in the usual way: in fact, they could not distinguish them, as the whole would be nearly solid, much the same as a mortar-battery. Where infantry or cavalry are to be fired at in ricochet, the pieces must not be elevated more than three degrees, otherwise their greatest effect would not be produced. Ships may likewise be acted upon by ricochet, if the shots are caused to strike the water at a *depressed* (instead of an *elevated*) angle of about four degrees, so as to touch the surface at from two hundred to two hundred and fifty yards from the battery. But this applies only to particular cases; for if the vessel be remote, or that any object is to be fired over, the same angle of elevation may be used, taking care so to proportion the charge, that the shot may light upon the water at about two hundred yards from the vessel, if she be large; but if small, the shot must light nearer to her, in proportion to her want of bulk.

It was necessary to say thus much of ricochet firing, in order to give a complete insight into the manner of enfilading by means of small charges of powder. The reader will likewise perceive that several guns may enfilade the same battery, in exactly the same line, merely by causing them to be removed farther from the object of attack, the one behind the other, only taking care that the parapet before each be sufficiently substantial to prevent accident to the other batteries in its front, and causing the more remote to charge higher, in order that their shot may be thrown sufficiently far to make the first bound in a proper manner, over the epaulement of the defence to be enfiladed. We should observe that the mode of enfilading before-mentioned, namely, by grazing directly over the crest of the parapet, may be extended to remote works; but unless they are manned for action little damage will be done, as the besieged will rarely fail to *house* their cannon, by pointing them towards the enfilading-battery; so that they may be far less exposed than when standing in their proper directions.

We shall annex to this article, which we have dwelt upon in deference to its importance in military affairs, a few general principles. 1st. That the descending enfilade is the most destructive in long ranges. 2dly. That the ricochet-enfilade is peculiarly adapted to short distances. 3dly. That the angle should, if practicable, be kept under ten degrees of elevation; the greater effect being generally in proportion to the less deviation from the horizontal direction. 4thly. That the more direct the fire may be along the line, or defence, to be enfiladed, the greater will be the damage done thereto, provided it be within such a parallel with the parapet as may subject both the cannon and the gunners to its range. 5thly. That if any angle is to be made with the line to be enfiladed, a few degrees in reverse are better than even half their number in advance; because, though the former may not strike any object in its original course, the shots may, after having grazed against the interior of the parapet, *genouillere*, &c. still do considerable damage; and, even though they should not either dismount a cannon, or kill any of the men on the battery, they must tear the garon-revetement far more than one of masonry, which is often put exteriorly, though not within: the latter would turn the shots

off, in all probability, and cause them to have only the effect of a weak fire *razant*. 6thly. It will be necessary to ascertain the thickness of the parapet behind which the enfilading shots are to trundle: in common fortifications it may suffice to compute, as nearly as may be practicable, upon about four toises, (or eight yards,) from the extremity of the superior slope of the angle; but in places where the parapets are made of masonry, less will commonly be necessary, for the purpose of striking somewhere upon the line of platforms, and of thereby dismounting the cannon. 7thly. Where howitzers are used for the enfilade, the traverses must be very numerous, to prevent the pieces of bursten shells from spreading to any extent. But, in such case, the traverses will not require so much solidity, as if opposed to heavy shots. 8thly. Where a remote battery is to be enfiladed, especially if the enfilade be direct, that is, in a line with the prolongation of such battery, great care must be taken to be exact in ascertaining its distance from that part of the defences which may be nearest to the enfilading party. This may, in general, be done, with precision, by means of two long ladders placed face to face, and elevated during the night, so as to give a command of the works then in a state of actual opposition; when the flashes from their cannon will prove a sufficient guide. This may, however, be done with more precision during the day time, though certainly with more danger; but the operation being certain and speedy, compensates for the risk. The enfilade on such occasion must not be by ricochet, but by descent. Those who are in front of the enfiladed battery, or nearly so, will see the effects of the shots, and can, by means of pre-concerted signals, give information accordingly to the enfiladers.

The following references to the figures in *Plate III. Fortification, fig. 1*, will explain more fully what has been said.

Let *AB* be the face of a bastion, whose salient or flanked angle, *B*, is battered in breach from *CC*. In such case, the besieged must make a very strong epaulement from *B* to *P*, on the adjoining face, to prevent the shots from the enfilading battery at *D* trundling upon the terre-pleine of the face *AB*; in aid of this resistance, the traverses, *S, S, S*, must likewise be thrown up. The battery at *D* being a direct enfilade, that is, in the line of the face *AB*, is highly destructive; while that at *E*, which is only  $15^\circ$  in reverse, is far less so. It is indeed evident, that one cannon at *D* would be more effectual than two at *E*; unless the shots from the latter should be thrown in so as to fall upon the nearest part of the interior of the parapet, as has been already implied: they would then be capable of tearing away the interior of the merlons, and of causing great numbers of splinters, &c. The battery at *F* is a direct-enfilade of the face of the remote bastion *H*; but its fire must not be in ricochet, (as that could never reach its object,) but by descent. At *I*, an enfilading battery is shewn in profile, the cannon being sunk, and the embrasure, *K*, having an inverted slope, covering the cannon from the fire of the battery at *L*. This slope being only  $10^\circ$ , admits the shots from the cannon to ascend, by means of a small charge, in a curve meeting the ground at *N*; thence reascending over the face *L*. (corresponding with *BP* in the upper figure,) so as to light again at *O*, upon the terre-pleins of the face *M*, (here seen in reverse, and corresponding with the interior of *AB* in the upper-figure;) whence it will again rise, and, if unimpeded, bound on in successively diminishing curves, until its force be expended. The dotted line, from the cannon *I* to *O*, on the bastion *M*, shews the direct or plunging-enfilade by descent, which is best adapted to cannon of a smaller calibre; the force of the shot being, in

this instance, unabated by any bound; as must be the case in ricochet, wherein, by striking at *N*, the impetus is considerably diminished. This diminution will be greater, in proportion as the elevation of the cannon is increased. As already stated, the enfilade of *H* from *F* will be of little moment, unless the battery at *H* be in action; but, as the obliquity of the embrasures may enable the enfiladers at *F* to act either in ricochet, or by descent into the reverse of *AC*, or even of *AB*, there might be considerable advantage gained by such a position. It is proper to state, that this does not appear to be generally practicable; as the distance from *C, C*, (the main breaching-batteries,) to *F* must render the latter rather insecure, and expose it both to the batteries of the place, and to the fallies of the garrison: it is therefore given merely as an illustration of the terms used in the explanation of all that relates to enfilade. When shipping, or craft of any description, lie behind a mole, so as to be secure from the direct fire of any battery, the ricochet-enfilade may be adopted, either by elevation, as shewn above; or by depression, as from the cannon at *P* directed downwards to *Q*; whence the shots will bound over the mole *R*, and fall among the vessels behind it. This is occasionally done to destroy vessels in a harbour, or to enfilade such as may be actively employed in any attack; and thus to force them to a change of position, rather than suffer themselves to be raked fore and aft with hot balls.

**ENFILED**, in *Heraldry*, is applied to a sword, on which is placed the head of a man or beast, or any other charge.

**ENFRANCHISEMENT**, the incorporating any man into a society or body politic. See **FREEDOM** and **FRANCHISE**.

Thus, he that by charter is made denizen of England, is said to be enfranchised. The like is understood of a person made a citizen of London, or other city or corporate town; because he is thereby made partaker of the liberties appertaining to the corporation whereof he is enfranchised.

**ENFRAPPANT**, *Fr.*, in *Music*, a term applied, in beating time, to the first note of a bar.

**ENGADINE**, in *Geography*, one of the highest vallies of Switzerland, in the canton of the Grisons. It is divided into the Upper and Lower Engadine. St. Martin's bridge on the river Inn separates the Lower Engadine from the Tyrol. The towns of this valley are less agreeable than those of the upper one; but the soil is uncommonly productive. In some places the roads are narrow and rocky, and nature displays its wildest scenes. The river Inn is often compressed in a narrow deep channel: there are, however, a few fine plains, where fruits come sooner to maturity than in the Upper Engadine, from which it is divided by the Pont-Alta. The situation of the upper valley is much higher; it has very long winters, and the air is generally cold. In the midst of summer, night frosts nip the corn and fruits. The towns are agreeably situated, and mostly handsome, built of free-stone, and painted white; even the barns are fine buildings. The river Inn flows slowly in a larger bed; there are several beautiful bridges of a single arch thrown over it. Near the pretty town of Schoulz are fourteen springs of mineral water of different qualities. There are several manufactures, chiefly iron works and founderies, in the Engadine, which give employment to a great number of its inhabitants, and an appearance of cheerfulness and comfort to their habitations.

**ENGAGE**, *To*, when applied to *Military* or *Naval Affairs*, means to attack. Perhaps no circumstance incident to warfare requires more precaution, or indeed more judgment,

judgment, than that relating to the giving battle to an enemy. The general, or commander of any description, who neglects to provide against those checks which arise, often when least expected, or for following up any advantage he may gain, especially if it be within the limits of his anticipations, must be totally unqualified for so responsible and so important a situation. We speak principally of proceedings in the field, where many alterations and much diversity may be perpetually offering; for we consider the manner in which battles on the ocean generally proceed, and in which they almost invariably terminate, to be so pre-eminent as to leave us only the opportunity of describing them, (as we shall do under the head of *ENGAGEMENT*;) and to debar us, unless indeed we wished to incur the charge of presumption, from stating when or how single ships or fleets should engage the enemy.

In the first instance, it will be absolutely necessary for the commander of an army to know, with precision, the states of health, of discipline, of fatigue, of supply, and of competency in general, of every corps composing his army. He must be thoroughly informed as to the condition and numbers of his cattle, of the amount of his provisions, and of the manner in which the several corps, the cattle, and the supplies, are distributed along his line. He must have a thorough knowledge of the numbers, the disposition, the supplies, and the probable resources, of the forces opposed to him; as well as of the nature of their warfare, their general habits, the strong posts in their rear, the opportunities they may have of forming ambuscades, or of retreating to advantage; and especially whether, in case of success, he may be able to avail himself of those invaluable opportunities which the valour and discipline of his troops may offer to his acceptance.

However confident a general may be of success, he must never lose sight of the possibility of a reverse: in truth, it is most generally found, that where the best preparations are made against disaster, the most decided victories are obtained. This is natural, both because the whole of a line feel inspired by the reflection, that due provision is made for the worst; and because, where such arrangements are carefully preconcerted, the appropriate remedy is prompt for application, and the enemy are rendered unable to continue in that line of successes, which, but for such apt opposition to their momentary or local advantages, must inevitably be at their command.

Whenever we observe that a commander courts the opinions of those whose rank and experience may qualify them to offer advice, we may consider it a most fortunate omen. The immortal Nelson always disclosed his plans, and opened his mind fully, to the admirals and captains under his command: he solicited the correction of whatever errors might have crept into his projects, and was eagerly anxious that all should have a competent understanding of his intentions. This ought ever to be the study of a commander; else, should he fall, or should unforeseen accidents occur in any part of his line, his successor, as well as his subordinates, must be totally at a loss either to continue victorious, or to arrest the progress of the enemy.

But perhaps the most essential point may be for a commander to ascertain how far his troops are well disposed to the cause; whether they proceed to engage with alacrity and zeal; and whether they have an entire confidence in the courage and abilities of their leaders. This part of the subject is sometimes overlooked, until it is too late to be remedied; and the moment of engaging is the moment of treason, or of cowardice. It is true, the British army may claim an exemption from these ungovernable mischiefs; but

no commander should be indifferent to matters which are within the scope of possibility, and which may often be avoided by a little courtesy, or by some well directed policy. We should consider, that in our time the most unforeseen events are daily brought forth; that the opinions of persons inimical to the welfare of the state are every day promulgated; and that, within these very few years, even a field officer of our army endeavoured to mislead those guards, who are exclusively appointed to protect his majesty's sacred and most valuable life. Fortunately for Britain,

“ Such divinity doth hedge our king,  
That Treason dared but peep at what it would !”

Therefore we may ever hope that the disposition of our soldiery will remain unshaken; and that we may find them, as they ever have been, bold, active, and obedient in the field, and ready on all occasions to engage in support of our king, and our constitution.

It may be proper to add, that too much ardour to engage may exist in an army: this is assuredly dangerous. There is a certain established coolness in veteran regiments, resulting from the presence of perhaps only a small portion of veterans among them, which is highly conducive to the character and to the prowess of the corps at large. Such regiments are admirably calculated for resistance; while new levies are generally more suited to the charge, and to those tremendous conflicts which speedily terminate the struggle in their quarter. In truth, we are well assured from the most respectable authorities, as well as from the numerous facts which proudly and pre-eminently offer themselves to our notice, that nothing can resist the attack of our new regiments; while, on the other hand, nothing can subdue the firmness and patience of our old ones.

*ENGAGEMENT*, in the *Military Profession*, relates to such conflicts as take place between bodies of armed men, generally regular troops, and especially to that kind of warfare which is carried on between armies of some magnitude, in contradistinction to those less extensive contests, which ordinarily are considered as skirmishes. Engagements may be either partial or general; in the latter case, they are commonly attended with marked and decided consequences; whereas, in the former instance, little or no difference may be made in the positions of the contending powers. We generally find, that, according to the modern mode of warfare, great ingenuity and cunning are exerted, for the purpose of deceiving the adversary into an opinion of a general attack. This is done with the intention of preventing reinforcements being sent from any part, the whole being kept in action, while the main attack is made on some point, either naturally weak, or by gaining which the fortune of the day may be determined in favour of the assailants. This, although it bears the appearance of a general engagement, is in fact but a partial assault; the greater portion of the contest falling upon a few regiments, which, unless properly supported, are commonly swept away: to say the least, they must suffer very considerably.

Previous to engaging the enemy, every attention must be paid to securing a retreat, in case of a check. This precaution is indispensable in all ordinary instances; though, in some situations, it may be found the best policy to destroy the means of evasion, under the intention of convincing the army that it has only the alternatives of victory or death. Thus, when Cæsar landed in Britain, he destroyed the fleet which had brought him to our shores; a measure which, in those times, compelled the invaders to fight to the last. They knew they had to contend with an enemy, from whom

## ENGAGEMENT.

whom no quarter was to be expected; therefore, like rebels, they struggled for life; they fought virtually with halters around their necks; and, thus rendered desperate, contended with such savage, such unrelenting fury, as necessarily caused the engagement to be sanguinary to an extreme.

Engagements are of two kinds; namely, either in the field, where the opposing parties are both divested of the protection of fortifications of any description, such as we ordinarily find to take place in open countries; the other consisting of that mixed kind of warfare, which comprises the attack and defence of *abbaties*, the crossing of rivers in the face of an enemy, and, on many occasions, the attacks made upon open towns, &c. With respect to those engagements which are connected with the forming of lines, or of fortifications of any description, we consider such to appertain to that protracted system included under the head of *siege*, which see; and the attacks upon such to be, not engagements, but assaults.

It is scarcely to be credited upon what very slight incidents the fate of an engagement may depend! Circumstances, which, if considered in the cabinet, should appear to be akin to impossibility, arise unexpectedly, and change the face of affairs instantaneously. Hence, during the moment of contest, a commander should be intent on obviating those mischiefs which must result from the falling back, or the failure, of any part of his army. He must carry in mind, and perhaps might advantageously delineate on a card, the great outline of the engagement; studying to choose such a position as may give him a general view of the field, but most especially of such portions as may either appear to him either weak, *ab origine*, or to be hard pressed by the enemy.

To describe an engagement is next to impossible; for though we might perhaps afford some general idea of the incidents usually occurring during a battle, such is the diversity to be found in the localities, as well as in the systems of warfare adopted even by persons in the same service, that to enter upon the investigation of the subject in all its bearings, and throughout its amplifications, would be to comprise a volume of no small magnitude. We must, therefore, content ourselves with observing, that the ordinary disposition for an engagement, where no particular *point d'appui* is in question, consists of two or more lines, composed chiefly of infantry, properly supported by artillery of various natures, that is to say, of brass 18 pounders, also of 12, 9, 6, and 3 pounders, with a portion of howitzers, commonly of  $4\frac{1}{2}$ , or  $5\frac{3}{4}$  inches diameter in the bore, or eventually up to 8 inches. These are placed in the intervals between the several regiments, while one or more parks of artillery are arranged in such parts of the several lines, as may appear to require that powerful aid; or on such commanding spots as may enable the artilleryists to act with greater effect against the enemy. See *TACTICS, Military*.

Where the ground may admit, the cavalry often commences the action, by endeavouring to prevent the enemy from forming upon, or taking possession of, strong positions. The horse artillery, together with the pieces of lighter construction which can be speedily withdrawn, advance to cannonade; while the infantry may be deploying from column into line, or forming according to the instructions of the generals commanding in the several quarters of the army; to whom the commander in chief previously communicates his intentions. During this time, the greatest order, coolness, and promptness, are indispensably necessary: it is now that superior discipline will manifest itself, and that the real powers of an army will be ascertained. Let it not,

however, be supposed, that that kind of symmetrical order which is the boast of our parade *martinets*, is to be found in the field of battle! Far otherwise; in lieu of regular firings by divisions, each individual loads and discharges his piece when, and how he can; in place of a regulated pace conforming to any particular cadence, the advances and retreats are generally too much divested of that order, and of that systematic uniformity, which so highly delight the fair sex when they visit our summer camps, to witness the splendid array attendant upon parade evolutions. In short, the celebrated song in the "Recruiting Serjeant" is the best, and most pithy description of an engagement we have ever heard, especially that part which relates to the most arduous portions of the contest.

" But the merriest joke of all,  
Is when to close attack we fall.  
Killing, wounding, maiming, butting,  
Dashing, flashing, slaying, cutting:  
Horse and foot,  
Both go to't;  
Blood and thunder!  
Then to plunder,  
Oh! what a charming thing's a battle!"

A very charming thing, indeed; especially when we consider that many of the wounded are often murdered by persons, chiefly women, who follow the several armies, for the purpose of plundering such unfortunate brave men as may be incapable of making resistance. It is, indeed, a well-known fact, that this iniquitous and disgraceful practice, is more than ever prevalent in many countries, whose inhabitants, being at least on a par with those of the most enlightened parts of the world, should rather endeavour to soften the rigours of war, than to perpetrate the most savage cruelties on those whose misfortune it may be to be disabled in the course of an engagement.

These fluctuations between victory and defeat, which sometimes alternate for hours together between contending armies, must afford the most lively interest to a spectator, and cannot fail to produce the most exquisite sensations of joy, or of misery, in the breasts of the respective commanders. What can afford a greater gratification than the complete success of an army? or what can occasion more pointed chagrin than the evidence of its defeat? Perhaps, of all the men who ever experienced such reverses, the old king of Prussia may be considered as the most illustrious instance of fortitude under disaster, and of moderation when successful. These good qualities, though they may have been coeval with his birth, must necessarily have been considerably enhanced, by that intense application the monarch paid to the discipline of his army. Hence, we are informed, that no reverse appeared to him irremediable, and that no victory was considered by him to be permanent. Such a man must have viewed an engagement under very peculiar impressions: he must have been most ardently intent upon the consideration of what evolutions would be most suited to the events passing under his notice; while at the same moment, his mind must have been actively employed in the consideration of resources, wherewith he might, according to the modern cant term, "carry on the war." We must, however, remark, that the great Frederick rarely had a large army; but that which he had, though comparatively small, was of immense strength: every part was systematically organized under the most severe code of discipline, and under the most penetrating observation. We have heard old officers state, that the Prussian army, under their immortal royal general, performed its evolutions, and preserved the

## ENGAGEMENT.

the same order, and went through their firings, as regularly while in action as when on their several parades. We fear this singular instance of military consistency, is not likely to be again displayed by the Prussian army at this date; nor, indeed, have we any authority, if past events are to guide us, for expecting to see, or hear, that they should throughout an engagement display those qualities which, however much we may commiserate the sufferings of those individuals whereof it was composed, characterized the military establishment of that now ill-fated country! We leave to our readers to contemplate what must be the feelings of the brave marshal Mollendorff, who, we believe, is the only surviving general now of the many that held commands under that military prince, whose existence in these times would, no doubt, have given a very different aspect to the affairs of Europe.

ENGAGEMENT, in a *Naval Sense*, denotes a particular or general battle at sea, or an action of hostility between single ships, or detachments, or squadrons of men of war: the whole economy of which may be arranged under the heads of preparation, action, and repair. The preparation is begun by issuing the order to clear the ship for action, which is repeated by the boatswain and his mates at all the hatchways. The hammocks are first removed; every sailor stowing his own bedding properly and firmly cording it with a lashing, or line provided for that purpose: as each side of the quarter deck and poop is furnished with a double network, supported by iron cranes fixed immediately above the gunnel or top of the ship's side; the hammocks, thus corded, are firmly stowed by the quarter-master between the two parts of the netting, so as to form an excellent barrier or fort of parapet, to prevent the execution of small shot on the quarter-deck: the tops, waite, and fore-castle, are fenced in the same manner.

At this time all heavy luggage, such as chests, &c. are handed down into the hold, and the surgeon, with his mates and assistants, together with whatever women may be on board, descend into a part called the cock-pit; which, being below the level of the water, is considered to be tolerably secure; various instances have, however, been known of shots, between wind and water, finding their way to that retirement.

At the same time the boatswain and his mates are employed in securing the sail-yards, to prevent them from tumbling down when the ship is cannonaded, whereby it might be disabled. The yards are secured by strong chains or ropes, besides those by which they are usually suspended. The boatswain also provides the necessary materials for repairing the rigging; and the carpenter and his crew prepare shot-plugs and mauls to close up any breach that may be made near the surface of the water, and provide their iron-works necessary to refit the chain-pumps. The gunner, with his mates and quarter-gunners, examine the cannon of the different batteries, and provide proper charges, &c. The master and his mates attend to the mending and trimming of the sails, &c. The lieutenants visit the different decks, taking care that all incumbrances are removed, and giving instructions to the other officers, that every thing may be ready for the expected engagement at a moment's warning. When the hostile ships have approached each other to a competent distance, the drums beat to arms: the boatswain and his mate pipe "all hands to quarters!" at every hatch-way. The persons appointed to manage the great guns immediately repair to their respective stations; crows, hand-spikes, rammers, sponges, powder-horns, matches, and train-tackles are placed in order by the side of every cannon. The hatches are laid to prevent any one from creeping into the lower

apartments. The marines are drawn up in rank and file, on the quarter-deck, poop, and fore-castle. The lashings of the great guns are let loose, and the tompions withdrawn: the whole artillery, above and below, is run out at the ports, and levelled to the point-blank range ready for firing. When the necessary preparations are finished, the commencement of the action is determined by the mutual distance and situation of the adverse ships, or by the signal from the commander in chief of the fleet or squadron. The cannon being levelled in parallel rows, projecting from the ship's side, the most natural order of battle is evidently to range the ships a-breast of each other, especially if the engagement is general. The most convenient distance is probably within the point-blank range of a musket, so that all the artillery may do effectual execution. The combat usually begins by a vigorous cannonade, accompanied with the united efforts of all the swivel-guns and small arms. Instead of firing platoons, or volleys of cannon at once, the general rule throughout the ship on these occasions is to load, sponge, and fire the guns with all possible expedition, yet without confusion or precipitation. The captain of each gun is enjoined to fire only when the piece is properly directed to its object. The lieutenants who command the different batteries traverse the deck, to see that the battle is prosecuted with vigour, and to animate the men in their duty. The midshipmen second these injunctions, and give assistance where it is required at the guns committed to their charge. The gunner takes care that the artillery is supplied with powder, and that the cartridges are conveyed along the decks in covered boxes.

During the action, the captain manœuvres his ship to the best advantage; causing the master so to lay her on the enemies' bows, or quarters, and especially under her stern, as may give those favourable results attendant upon a safe, but annoying, position. Should any intervals arise, owing to the situations of the several ships, it is employed in clearing the decks, in repairing the damaged rigging, and in providing for a renewal of the engagement. If, as very often happens, the enemy make sail with the view to escape, the guns are secured, while all hands turn to for the purpose of giving chase: in this instance, the great object is to come up with the flying foe; therefore all these sails which were furled or clued up, with the intention of either having less to manage, or to keep them free from danger, are now spread to the gale, and every effort is made to regain a position within such a distance as may cause the enemy to strike his flag, and to surrender. Should he still persist, the engagement must continue, until, being a complete wreck, he may consider further opposition useless. So soon as he has struck, his ship is taken possession of by a detachment from the victor's crew, and the whole of the subdued party are put under hatches in the hold, or, if necessary, are otherwise secured in the bilboes, &c. while a prize master, generally a lieutenant, is put on board, for the purpose of navigating the prize, according to such orders as he may receive.

It sometimes happens, that, where an enemy is very determined, it is necessary to board; indeed, this not unfrequently occurs, owing to vessels adventitiously coming in contact. Previous to the adoption of this desperate measure, it will be absolutely necessary to consider well how far it may be likely to succeed. If the opposing crew be numerous, and especially if abounding in marines, or if there be any number of military on board, much management, activity, and resolution will be required to carry the point; which is generally effected by laying along the lee waite or quarter, or perhaps upon the bow, and, after having grappled,

grappled, by means of chains, or of small boarding grap-nails suspended by chains from the yards, to lower down the boarding platforms, (if there be any,) and thus to rush upon the enemy's deck. In some instances, ships have been boarded by entering at the ports, stern, or quarter gallery, &c. either of which modes will often succeed, where the whole of the opposing crew rush with too much precipitation, to the upper works, with the intention of resisting those who are about to board upon the deck. The bowsprit is frequently resorted to, as the means of entering an enemy's ship: this, being laid over the stem, or taffrail, will generally enable the boarders to proceed with sufficient facility, while the marines are employed in keeping up a sharp fire, to drive the defenders off the poop. It is, however, a very hazardous concern, and chiefly resorted to on desperate occasions, by privateers, or where, though strong in point of crew, a vessel may not be of sufficient force to lie alongside her opponent. A repulse in boarding is peculiarly dangerous, and very commonly leads to defeat. It almost invariably happens, that, on such occasions, great numbers of the boarders are destroyed; whereby the residue of the ship's company are considerably dispirited; at least, this is an ordinary result among foreigners; British tars are not so easily daunted, but may be again, and again, led to the attack.

When the engagement is concluded, they begin the repair. The cannon are secured by their breachings and tackles; the sails that have been rendered unserviceable, are unbent; and the wounded masts and yards struck upon the deck, and fished or replaced by others. The standing rigging is knotted, and the running rigging spliced wherever this is necessary. Proper sails are bent in the room of those that are become useless. The carpenter and his crew repair breaches in the ship's hull by shot-plugs, pieces of plank, and sheet-lead. The gunner and his assistants replenish the allotted number of charged cartridges, and refit the damaged furniture of the cannon.

When two fleets or squadrons are preparing for engagement, it will be the endeavour of the admiral or commander in chief to come to action as soon as possible. To facilitate the execution of the admiral's orders, the whole fleet is ranged into three squadrons; each of which is classed into three divisions, under the command of different officers. Before the action begins, the adverse fleets are commonly drawn up in two lines parallel to each other, and close-hauled. When the admiral displays the signal for the line of battle, the several divisions separate from the colours in which they were disposed according to the usual order of sailing, and every ship crowds into its station in the wake of the next a-head, at the distance generally of about fifty fathom; which distance is regularly observed from the van to the rear: though the admiral may sometimes find it necessary to contract or extend his line, according to the length of that of his adversary; always taking care that his own line be secure from being doubled, which might throw his van and rear into confusion. When the reverse fleets approach each other, the courses are commonly hauled up in the brails, and the top-gallant sails and stay-sails, furled; the frigates, tenders, and fire-ships, being hauled upon the wind; lie at some distance behind the line of battle; and transports and store ships lie beyond these, at a still greater distance from the scene of action; and if the number of ships allows it, a body of reserve from the different squadrons is selected to cover the fire-ships, &c. and stationed opposite to the weakest parts of the line, so that they may readily fall into the line in case of necessity. Each ship forming the line should keep close to its station during the engagement; the assault of

boarding being seldom permitted unless in single action: because the regularity of a close line constitutes the principal force of the fleet; and the skill of the admiral is greatly concerned in keeping his line, notwithstanding unequal attacks and damage, as complete as possible. If he proves victorious, he should prosecute his victory as much as possible, by seizing, burning, or destroying the enemies' ships. If he is defeated and reduced to the necessity of retreating, he may judge it expedient, for greater security, to range his fleet into the form of a half-moon, placing himself in the centre. The enemies' ships that attempt to fall upon his rear will thus be exposed to the fire of the admiral and his seconds, and the escape of his own ships will be facilitated, whilst the pursuit of his adversary is retarded. Upon the whole, the real force of superiority of a fleet, consists less in the number of vessels and the vivacity of the action, than in good order, dexterity in working the ships, presence of mind, and skilful conduct in the admiral and captains. Falconer's Marine Dict. art. *Engagement*.

There formerly existed certain supposed axioms, in regard to the several modes of forming in line of battle a-head, or a-breast; and much attention was paid to the weather-gage, as well as to other such matters: fleets used then to manoeuvre for several days, obviously intent upon gaining some particular position, which was supposed to be indispensably necessary towards a successful issue. Of late years this has been totally, or at least very generally neglected; for in lieu of fleets, or single ships, now dancing minuets for such a purpose, we see them ranging up with little ceremony, and intent only on getting into action; whatever may be the state of the wind or of the weather. All that a British commander requires of his master, nowadays, is, "Lay me alongside the enemy;" a few guns more or less, or even an extra deck, on the part of the enemy, being disregarded. It is to this spirit, that our shores are indebted for safety, and our commerce to that wide range afforded by the universal command which Britain holds over the ocean. It is with the utmost pride and satisfaction, we witness the glorious exertions of our invincible tars: for such we may fairly designate men who, regardless of every danger, and urged by the most patriotic zeal, bear away the palm when, and wherever the enemy, however superior in guns, or in numbers, give them the opportunity of displaying that valour which, though uncontrollable in opposing a foe, is rapidly metamorphosed into humanity, so soon as the victory may be proclaimed, or that the voice of distress may be heard! Surely we never can sufficiently reward those heroes who, as Hudibras says, stand forward—

"To fight our battles in our steads,  
And have their brains beat out o' their heads;  
Encounter in despite of nature,  
And fight at once with fire and water,  
With pirates, rocks, and storms, and seas."

A naval engagement is a branch of warfare in which the British character appears to the utmost advantage, and in which we stand confessedly pre-eminent over the whole universe. We derive the more satisfaction, from the reflection, that our credit and prowess are not ephemeral, nor dependant upon any temporary weakness on the part of our opponents: we contemplate them as heir-looms, bequeathed to us from a noble and brave ancestry, whose examples have been duly followed, and whose reputation has, no doubt, contributed to that zeal, and to that emulation, which pervade every part of the British navy, and induce our tars to persevere in their struggles for the preservation of our rights and liberties as a people; while,

at the same time, each individual aims to uphold his own character for bravery, subordination, and generosity. See **BATTLE**, **BOARDING**, **LINE of Battle**, and **SIGNAL**.

**ENGAGEMENT**, in *English History*, was the obligation imposed by Oliver Cromwell required to be signed by every member of the First Parliament in 1654, assembled by his authority, after he was declared Protector, viz. "I. A. B. do hereby freely promise and engage myself to be true and faithful to the Lord Protector, and to the commonwealth of England, Scotland, and Ireland, and shall not (according to the tenure of the indenture whereby I am returned to serve in this present parliament) propose or give any consent to alter the government, as it is settled in one single person and a parliament." Many, who refused to sign this engagement, were excluded from the house.

**ENGALLA**, in *Zoology*, the Ethiopian hog or African wild boar. See *Sus Æthiopicus*.

**ENGALLIM**, in *Ancient Geography*, a town of Judea, in the tribe of Benjamin, situated on the coast of the Dead sea, where, according to St. Jerom, the river Jordan discharged itself into that sea.

**ENGAMOS**, in *Natural History*, the name given by the people of some parts of Guinea to a root very common there, and much resembling our larger sort of turnips, but not so sweet or juicy. They commonly boil these with their battatas, in the same kettle with their meat. The latter of these roots, which is considerably different from our potatoe, gives a fine flavour to the whole, and makes the broth and meat taste as if rose-water were added to it. The engamos also partakes of the flavour, and in this case becomes very agreeable. Phil. Trans. N<sup>o</sup> 108.

**ENGANNIM**, in *Ancient Geography*, a city in the plain belonging to Judah, Josh. xv. 34.—Also, a city of Issachar; given to the Levites of Gerihon's family. Josh. xix. 21. xx. 29.

**ENGANNO**, or **DECEIT Island**, in *Geography*, an island in the Eastern sea, at a small distance from the S.W. coast of the island of Sumatra. S. lat. 5 9'. E. long. 102° 44'.

Ships that pass the straits of Sunda, in the westerly monsoon, generally run in sight of Enganno. This island is 6 or 7 leagues in length, and not quite half as broad. It is not high, and can only be discerned at the distance of 5 leagues. It is covered with trees, and always appears green. For a more particular account of this island, see Phil. Trans. for 1778.

**ENGANO, CAPE**, a cape on the east coast of the island of St. Domingo. N. lat. 18° 27'. W. long. 68° 52'.

**ENGANO**, or **ENGANNO, Cape**, the N.E. point of the island of Luçon, in the East Indian sea. N. lat. 17° 45'. E. long. 121° 20'.

**ENGASTRIMANTES**, *Ἐγαστρίμαντες*, in *Antiquity*, called also *Engastrimythi*, *Ἐγαστρίμυθοι*, a designation given to such diviners as were possessed with demons, which either lodged or spoke within their bodies. Pott. Archæol. Græc. lib. ii. cap. 12. tom. i. p. 301.

**ENGASTRIMYTHUS**, *Ἐγαστρίμυθος*, or *Engastrimander*, a person who speaks from, or with the belly, without opening his mouth; or, if open, without stirring the lips.

Thus called by the Greeks, from *ἔγαστρον*, belly, and *μῦθος*, speech; and by the Latins, *ventriloquus*, quasi *ex ventre loquens*.

The ancient philosophers, &c. are divided on the subject of the *engastrimythi*: Hippocrates mentions it as a disease. Others will have it a kind of divination, and ascribe the

origin and first discipline thereof to one Euryelus, whom nobody knows any thing of. Others attribute it to the operation or possession of an evil spirit; and others, to art and mechanism.

The most eminent *engastrimythi* were the Pythians or priestesses of Apollo, who delivered oracles from within, without any action of the mouth or lips.

St. Chrysostom and Occumenius make express mention of a sort of divine men, called by the Greeks *engastrimandri*, whose prophetic bellies pronounced oracles.

M. Schottus, library-keeper to the king of Prussia, in a Dissertation on the Apotheosis of Homer, maintained that the *engastrimythi* of the ancients were only poets; who, when the priests could not speak in verse, supplied the defect, by explaining or delivering in verse what Apollo dictated in the cavity of the basin, placed on the sacred tripod.

Leo Allatius has an express treatise on the *engastrimythi*. See **VENTRI-LOQUISTS**.

**ENGEDI**, in *Ancient Geography*, *q. d.* the fountain of the goat, called also *Hazazon-Tamar*, or the palm-tree city, from the great quantity of palm-trees that surrounded it, a city of Palestine, in the tribe of Judah (Josh. xv. 62.), situated near the lake of Sodom, 300 furlongs from Jerusalem, not far from Jericho, and the mouth of the river Jordan. It was in a cave of the wilderness of Engedi, that David had an opportunity of killing Saul, and of sparing his life, then in pursuit of him. 1 Sam. xxiv. 1, 2, 3; &c.

**ENGEL**. See **ANGLEN** and **ANGLES**.

**ENGELACH**, in *Geography*, a town of Germany, in the circle of Lower Saxony; and bishopric of Hildesheim; 15 miles S.W. of Alfeld.

**ENGELBERG**, an extensive narrow valley of Switzerland, in the canton of Underwalden; its length exceeds twelve miles, and it is hardly six miles broad. It was formerly called the *Hahnenberg* (Cocks' mountain), but when the abbey church was consecrated, some inhabitants pretended they had heard the melodious concerts of the angels in heaven, which made them call it *Engelberg*, (the Angels' mountain). The inhabitants are numerous and remarkable for the innocence of their manners, and for their hospitality to strangers.

The abbey of Engelberg is 9 miles S.W. of Altorf. It was founded in the year 1125.

**ENGELBRECHTS**, a town of Germany, in the archduchy of Austria; 95 miles N.N.W. of Bavarian Waidhoben.

**ENGELHARTZEL**, a town of Germany, in the archduchy of Austria; 9 miles E. of Passau.

**ENGELHAUS**, a town of Bohemia, in the circle of Saatz; 2 miles E.S.E. of Carlsbad.

**ENGELHOLM**, a town of Sweden, in the province of Schonen, or Scania, situated at the mouth of a river which runs into the Cattegat, 12 miles from Helsingborg. It is the twentieth town in rank among those which vote in the Swedish diet. Its name is said to be derived from the Angles, who either first came from this neighbourhood, or passed over to it from Denmark, and built the place for the convenience of trade. The latter conjecture is the most probable.

**ENGELSBURG**, a town of Silesia, in the principality of Appau; 5 miles N.N.W. of Freudenthal.

**ENGELSBURG**, a small town of Prussia, in the district of Culm, with an ancient castle not far from Graudontz.

**ENGELSDORF**, a town of Bohemia, in the circle of Boleslaw; 10 miles N.N.E. of Krottau.

**ENGELSTEIN**,

ENGELSTEIN, a town of Prussia, in the province of Natangen; 48 miles S.E. of Königsberg.

ENGELSTETTEN, a town of Germany, in the archduchy of Austria; 23 miles E. of Vienna.

ENGEN, a town of Germany, in the circle of Swabia, and principality of Stullingen; 12 miles N.N.E. of Schaffhausen, and 20 N.N.W. of Constance.

ENGENDERING, or INGENDERING, the act of begetting or producing the kind, by way of generation.

The term is likewise applied to other productions of nature: thus, meteors are said to be engendered in the middle region of the air. Crude fruits engender worms. The ancients believed, that insects were engendered of putrefaction.

ENGENTHAL, in *Geography*, a town of Germany, in the circle of Franconia; 13 miles E. of Nuremberg.

ENGER, a town of Germany, in the kingdom of Westphalia, and county of Ravensburg; 3 miles W. of Herwarden.

ENGER Sea, a lake of Carinthia, 10 miles N.N.W. of Feltkirchen.

ENGERSTORFF, a town of Germany, in the archduchy of Austria; 10 miles S.W. of Zistersdorf.

ENGETAL, a valley of Switzerland, in the canton of Basle, remarkable for its abbey, which was secularized in 1534, and where a bible was printed at the end of the fifteenth century, with N. Lyra's notes.

ENGGISTEIN, a small town of Switzerland, one mile from Worbe, remarkable for its mineral springs, on whose account it is much visited in the summer season. The water contains a little copper. The accommodations of the place are very good.

ENGHELBRECHT, CORNELIUS, in *Biography*, a painter, born at Leyden in 1468. Having imitated the works of John Van Eyck, at Bruges, he returned to his own country, and had the honour of being the first who taught the Dutch to paint in oil; in which he wrought with very great reputation in his time, as well as in distemper; and was then accounted among those most deserving of estimation.

He was not quite so dry or formal in his manner of design as the painters of that period; and he cast his draperies with more care, and better style, than they. His most admired performance is the representation of the "Lamb" in the Revelation, which he painted for a chapel in the church of St. Peter at Leyden. The composition consists of an immense crowd of figures, angels, martyrs, doctors, and fathers of the church, &c. and all the "holy hierarchy of heaven," combined together with an immense multitude of persons of all nations. This picture is very ingenious in the painting of the various parts, but it must owe its reputation more to the lack of knowledge of the better qualities of art at the time it was painted, than to its own intrinsic worth. This artist died in 1533, at 65.

ENGHIEN, or ENGUIEN, in *Geography*, a small town of France, in the department of Jemmappe, chief place of a canton, in the district of Mons, with a population of 3045 individuals. It is 18 miles S.W. of Brussels, and 15 N. of Mons. N. lat. 50° 40'.

The canton contains 10 communes, and 13,674 inhabitants, on a territorial extent of 140 kilometres. It is from this place that the eldest sons of the princes of Condé in France, the last of whom was so basely murdered by the orders of the French emperor Napoleon, derived the title of duke.

ENGINIA, an island near the coast of the Morea, an-

ciently called *Ægina*, which see. *Ægia* gives name to a gulf on the S.E. coast of European Turkey, formerly denominated *Sinus Saronicus*. See *ÆGINA*.

ENGINE, in *Mechanics*, a compound machine, consisting of several simple ones, as wheels, screws, levers, or the like, combined together, in order to lift, call, or sustain a weight, or produce some other considerable effect, so as to save either time or force.

The word is formed of the French *engine*; of the Latin *ingenium*, wit; because of the ingenuity required in the contrivance of engines, to augment the effect of moving powers.

The kinds of engines are innumerable; some for war, as the ballista, catapulta, scorpio, aries, &c. others for the arts of peace, as mills, cranes, presses, clocks, watches; engines to drive piles, to bore cannon and water-pipes, (see BORING), to raise water, wheel and water-works; to extinguish fire, see FIRE-engine, &c. See HYDROCANISTERIUM. See STEAM-engine, &c. See also INSTRUMENT.

ENGINE for cutting Wheels. See CUTTING-Engine.

ENGINE for cutting Fusées. See FUSEE-Engine.

ENGINE for ornamenting a Watch-case. See ROWS-Engine, or ROSE-Engine.

ENGINE for dividing Circles, Quadrants, Sextants, and Octants. It is not our intention in this place to enter into the history of the different methods of dividing astronomical instruments into degrees and their sub-divisions, as successively practised by Tycho Brahe, Hevelius, Dr. Hook, Mr. Abraham Sharp, Olaus Roemer, Mr. Graham, Mr. Jon. Sisson, Mr. Bird, Mr. Ramsden, and Mr. Troughton, without the aid of an engine; but, as we propose to treat the subject at some length under our article GRADUATION of *Astronomical Instruments*, we beg leave to refer the reader to that head for such particulars as relate to the manual operations performed by the beam-compass and otherwise, which are necessary for graduating all circles and other instruments, that are too large to be graduated by an engine.

Among all the improvements in chronometers and nautical instruments, that owed their origin, during the last century, to the munificent encouragement of the honourable Board of Longitude, there is none that has so much contributed to the interest of navigation, considered as a science, as the engine at present to be described; the facility, and at the same time the accuracy, with which the measuring portion of any nautical instrument, however portable, can now be divided by our best engines, are truly astonishing; the fine dividing-strokes, which, in many instances, are scarcely visible to, and not legible by the naked eye, when magnified by a suitable lens, are perceived to be laid down with such perfect equality, as to relative distances, that no one who has not examined the means by which they were effected, can conceive the possibility that the expedition, with which the divisions are made, is equal to the accuracy with which they are measured and marked down. In Mr. Smeaton's paper, read to the Royal Society of London, on Nov. 17, 1785, on the "Graduation of Astronomical Instruments," he mentions an engine, made by Mr. Henry Hindley of York, which indented the edge of any circle in such a way, that a screw with fifteen threads acting at once, would, by means of a micrometer, read off any given number of divisions, so as to answer the purpose of sub-dividing the circle. It does not, however, appear that this engine, though it divided the circles of Hindley's equatorial instruments, was intended or adapted so much for graduating circles as for cutting the teeth of wheels in clock-work. (See CUTTING-Engine.) The year in which it was seen by

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by Mr. Smeaton was 1741, and, consequently, was in Graham's time, who died in 1751. According to the same author, Mr. Ramsden, in consequence of the reward offered by the Board of Longitude to Mr. Bird, for his method of dividing, in the year 1760, turned his thoughts towards the contrivance of an engine that would divide nautical instruments with sufficient accuracy, without the tediousness of manipulation. Accordingly, considering the nature and properties of the endless screw, and probably contemplating what Hindley had previously done in this way, he completed an engine with an indented plate, or wheel, of thirty inches diameter, which, though it did not completely answer his expectations to their full extent, yet was found very useful for dividing theodolites and such common instruments with great facility. This was effected before the spring of 1768, and, in 1774, a much larger and better engine was produced, with an indented plate of 45 inches diameter, which divided a sextant for Mr. Bird's examination so accurately, that the Board of Longitude, ever ready to remunerate any successful endeavour to promote the lunar method of determining the longitude at sea, did not hesitate to confer an handsome reward on the inventor, but on condition that the said engine might be at the service of the public, and that Mr. Ramsden would publish an explanation of his method of making and using it, which he accordingly did in a quarto pamphlet in the year 1777. The sum of money given to Mr. Ramsden was 615*l.*, of which 300*l.* was considered as a reward for his improvement in the art of dividing instruments by means of his engine, and the remaining 315*l.* was paid in consideration of his making over the property of the said engine to the Commissioners of Longitude, for the good of the public. The description which Mr. Ramsden published, being short and explicit, cannot well be abridged, and the drawings, intended as a guide for other artists to work by, are explanatory of all the parts of the engine, as detached from one another; we have therefore given reduced engravings of all the figures, as they were originally arranged, and propose to copy the description without any other alteration than what the references to our plates required.

*Mr. Ramsden's Engine.*—“This engine consists of a large wheel of bell-metal, supported on a mahogany stand, having three legs, which are strongly connected together by braces, so as to make it perfectly steady; *fig. 1. Plate VII. of Engines*, is a perspective representation of the body thus united. On each leg of the stand is placed a conical friction-pulley, whereon the dividing-wheel rests: to prevent the wheel from sliding off the friction-pulleys, the bell-metal centre under it turns in a socket on the top of the stand. The circumference of the wheel is ratched or cut, by a method to be hereafter described, into 2160 teeth, in which an endless screw acts. Six revolutions of the screw will move the wheel a space equal to one degree. Now a circle of brass being fixed on the screw-arbor, having its circumference divided into 60 parts, each division will answer to a motion of the wheel of ten seconds; six of them will be equal to a minute, &c. Several different arbors of tempered steel are truly ground into the socket in the centre of the wheel. The upper parts of the arbor, that stand above the plane, are turned of various sizes, to suit the centres of different pieces of work to be divided. When any instrument is to be divided, the centre of it is very exactly fitted to one of these arbors, and the instrument is fixed down to the plane of the dividing wheel, by means of screws, which fit into holes made in the radii of the wheel for that purpose. The instrument being thus fitted on the plane of the wheel, the frame which carries the dividing-point is connected at one

end by finger-screws with the frame which carries the endless screw; while the other end embraces that part of the steel arbor which stands above the instrument to be divided, by an angular notch in a piece of hardened steel; by these means both ends of the frame are kept perfectly steady and free from shake.

The frame carrying the dividing-point, or tracer, is made to slide on the frame which carries the endless screw to any distance from the centre of the wheel, that the radius of the instrument to be divided may require, and may be there fastened by a pair of clamps; and the dividing-point, being connected with the clamps by the double-jointed frame, admits a free and easy motion towards or from the centre, for cutting the divisions without any lateral shake. From what has been said it appears, that an instrument thus fitted on the dividing-wheel may be moved to any angle by the screw and divided micrometer circle on its arbor, and that this angle may be marked on the limb of the instrument with the greatest exactness by the dividing-point, which can only move in a direct line tending to the centre, and is altogether freed from those inconveniences that attend cutting by means of a straight edge. This method of drawing lines will also prevent any error that might arise from an expansion or contraction of the metal, during the time of dividing. The screw-frame is fixed on the top of a conical pillar, which turns freely round its axis, and also moves freely towards or from the centre of the wheel, so that the screw-frame may be entirely guided by the frame which connects it with the centre: by these means any eccentricity of the wheel and the arbor would not produce any error in the dividing; and by a particular contrivance, hereafter described, the screw, when pressed against the teeth of the wheel, always moves parallel to itself; so that a line joining the centre of the arbor and the dividing-point, continued, will always make equal angles with the screw. The rest of the parts are represented in *Plates VIII. and IX. of Engines*, where the figures are numbered in succession from 2 to 14 inclusively, which are more easily referred to than the figures in the original plates. *Fig. 2* is a plan of reduced dimensions, of which *fig. 3* represents a section on the line  $\Pi A$ . The large wheel, *A*, is 45 inches in diameter, and has 10 radii, each supported by edge-bars, as seen in *fig. 3*. These bars and radii are connected by the circular ring *B*, 24 inches in diameter, and 3 deep; and, for greater strength, the whole is cast in one piece in bell-metal. As the whole weight of the wheel, *A*, rests on its ring *B*, the edge-bars are deeper where they join it; and from thence their depth diminishes, both towards the centre and circumference, as seen in the figure. The surface of the wheel, *A*, was worked very even and flat, and its circumference turned true. The ring *C*, of which a section is seen in *fig. 3*, made of fine brass, was fitted very exactly on the circumference of the wheel, and was fastened thereon with screws, which, after being screwed as tight as possible, were well rivetted. The face of a large chuck being turned very true and flat in the lathe, the flattened surface, *A*, of the wheel was fastened against it with hold-fasts; and the two surfaces and circumference of the ring *C*, a hole through the centre, and the plane part round it, together with the lower edge of the ring *B*, were all turned at the same time. *D* is a piece of hard bell-metal, having the hole that receives the steel-arbor made very straight and true. This bell-metal was turned very true on its arbor, and its face, that rests against the wheel, was made very flat, so that the steel-arbor might stand perpendicular to the plane of the wheel: this bell-metal was fastened to the wheel by six steel screws. A brass socket, *Z*, is fastened on the centre of the mahogany stand,

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and receives the lower part of the bell-metal piece D, being made to touch the bell-metal in a narrow part near the mouth, to prevent any obliquity of the wheel from bending the arbor: good fitting is by no means necessary here, since any shake in this socket will produce no bad effect, as will appear when the cutting-frame is described. The wheel was then put on its stand, the lower edge of the ring, B, resting on the circumference of the three conical friction-pulleys W, to facilitate its motion round its centre. The axis of one of those pulleys is in a line joining the centre of the wheel and the middle of the endless screw, and the other two placed so as to be at equal distances from each other. F is a block of wood (*fig. 1.*), strongly fastened to one of the legs of the stand; the piece, *g* (*figs. 1 and 12.*), is screwed to the upper side of the block, and has half holes, in which the transverse axis, *b*, (*figs. 1 and 11.*) turns; the half holes are kept together by the screws *i*. The lower extremity of the conical pillar, P, (*figs. 1 and 11.*) terminates in a cylindrical steel pin *k*, which passes through and turns in the transverse axis *b*, and is confined by a cheek and screw. To the upper end of the said conical pillar is fastened the frame G, (*figs. 5 and 9.*), in which the endless screw turns; the pivots of the screw are formed in the manner of two frusta of cones joined by a cylinder, as represented at X, in *fig. 9.* These pivots are confined between half holes, which press only on the conical parts, but do not touch the cylindrical parts; the half holes are kept together by screws, *a, a*, which may be tightened at any time, to prevent the screw from shaking in the frame. On the screw-arbor is a small wheel of brass, K, having its outside edge divided into 60 parts, and numbered at every 6th division with 1, 2, &c. to 10. The motion of this wheel is shewn by the index, *y*, on the screw-frame G. H represents part of the stand (*fig. 1.*) having a parallel slit in the direction towards the centre of the wheel, large enough to receive the upper part of the conical brass pillar P, which carries the screw and its frame; and as the resistance, when the wheel is moved by the endless screw, is against that side of the slit, H, which is towards the left hand, that side of the slit is faced with brass, and the pillar is pressed against it by a steel spring on the opposite side: thus is the pillar strongly supported laterally, and yet the screw may be easily moved from or against the circumference of the wheel, and the pillar will turn freely on its axis, to take any direction given it by the frame L, lying over the wheel in *fig. 1.* and seen more distinctly in *fig. 13.*

At each corner of the piece I, seen in *fig. 1.* and also detached in *fig. 8.* are as many screws, *n*, of tempered steel with polished conical points: two of them turn in conical holes in the screw-frame, near *o*, *fig. 9.*; and the points of the other two turn in holes in the piece Q, *fig. 7.*: the small end screws, *p*, are of steel, which, being tightened, prevent the conical pointed screws from unturning, when the frame is moved. The brass frame L, *figs. 1 and 13.* serves to connect the endless screw, its frame, &c. with the centre of the wheel; each arm of this frame is terminated by a steel screw, that may be passed through any of the holes, *q*, in the piece Q, *fig. 7.* as the thickness of the work to be divided on the wheel may require, and are fastened by the finger-nuts *r*, seen in *figs. 1 and 2.* At the other end of this frame is a flat piece of tempered steel *b*, wherein is an angular notch: when the endless screw is pressed against the teeth of the circumference of the wheel, which may be done by turning the finger-screw S, seen in *figs. 1 and 2.* to press against the spring *t*, this notch embraces and presses against the steel-arbor *d*. This end of the frame, too, may be raised or depressed, by moving the tri-

angular or prismatic slide *u* (*fig. 14.*), which may be fixed at any height by the four steel screws *v*. The bottom of this slide has a notch *k*, having its plane parallel to the endless screw; and by the point of the arbor *d*, resting in this notch, this end of the frame is prevented from tilting: the screw, S, also is kept fast by the finger-nut *w*, in *fig. 2.*

The teeth on the circumference of the wheel were cut by the following method. Having considered what number of teeth on the circumference would be most convenient, which in this engine is 2160 or  $360 \times 6$ , I made, says Mr. Ramden, two screws of the same dimensions of tempered steel, the interval between the threads of which being such as I knew by calculation would come within the limits of what might be turned off the circumference of the wheel; one of these screws, which was intended for ratcheting or cutting the teeth, was notched across the threads, so that the screw, when pressed against the edge of the wheel and turned round, cut in the manner of a saw. Then having a segment of a circle a little greater than  $60^\circ$ , of about the same radius with the wheel, and its circumference made true from a very fine centre, I described an arch near the edge, and set off the chord of  $60^\circ$  on this arch. This segment was substituted for the wheel, and had its edge ratched or indented; and the number of revolutions and parts of the screw head contained within the arch of  $60^\circ$  were counted. The radius was corrected in the proportion of 360 revolutions, which ought to have been in  $60^\circ$ , to the number actually found; and the radius so corrected was taken in a pair of beam compasses: while the wheel was on the lathe, one foot of the compasses was put in the centre, and with the other a circle was described on the ring; then half the depth of the threads of the screw being taken in the dividers, was set from this circle outwards, and another circle was described cutting this point; a hollow was then turned on the edge of the wheel of the same curvature as that of the screw, at the bottom of its threads; the bottom of this hollow was turned to the same radius as the outward one of the two circles before-mentioned.

The wheel was now taken off the lathe, and the bell-metal piece D, *fig. 3.* was again screwed to its place; not to be removed any more. From a very exact centre, a circle was described on the ring C, *fig. 4.* about  $\frac{1}{16}$ ths of an inch within where the bottom of the teeth would come; this circle was divided with the greatest possible exactness, first into 5 parts, and each of these again into 3; these parts were then bisected 4 times; *i. e.* supposing the whole circumference of the wheel to contain 2160 teeth, a fifth part would be 432, a fifteenth part (or  $5 \times 3$ ) would be 144, and this last number bisected four times would give 72, 36, 18, and 9 respectively; but as it was apprehended that some inaccuracy would arise from quinquesection and trisection, another circle was described on the same ring, at  $\frac{1}{16}$ th of an inch within the former circle, and divided by continual bisections into the portions 2160, 1080, 540, 270, 135,  $67\frac{1}{2}$ , and  $33\frac{3}{4}$ ; and as the fixed wire, to be described presently, crossed both the circles, it was a check on their agreement at every 135 revolutions, and after ratcheting at every  $33\frac{3}{4}$ ; but as no sensible difference was perceived in the two circles, the former was chosen for ratcheting: and as the coincidence of the fixed wire with an intersection would be more exactly determined than with a dot or division, the intersections in both circles were used.

The arms of the frame L, *figs. 1 and 13.* were connected by a thin piece of brass  $\frac{1}{4}$  of an inch broad, having a hole of  $\frac{1}{16}$ ths of an inch diameter in the middle; across this hole a silver wire was fixed exactly in a line to the centre of the wheel;

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wheel; the coincidence of this wire with the intersections was examined by a lens of  $\frac{7}{8}$ ths of an inch focus, fixed in a tube, that was attached to one of the arms L. Now a handle, or winch, being fixed on the end of the screw-arbor, the division marked 10 on the circle K was set to its index, and, by means of a clamp and adjusting screw for that purpose, the intersection marked 1 on the circle C was set exactly to coincide with the fixed wire; the screw was then carefully pressed against the circumference of the wheel, by turning the finger-screw S; then, the clamp being removed, the screw was turned by its handle just 9 revolutions, till the intersection marked 240, *fig. 4*, came nearly to the wire; the finger-screw S was now turned back, and the dividing screw released from the edge of the wheel, which was here turned back till the intersection marked 2 exactly coincided with the wire; the division 10 on the micrometer circle was then set to its index as before, and the screw pressed against the edge of the wheel by the finger-screw S; then, the clamps being removed, the screw was turned a second 9 revolutions, till the intersection marked 1 nearly coincided with the fixed wire; the screw was again released, and the same operation was repeated till the teeth were faintly marked all round the circumference of the wheel. The impression was made deeper by thus going three times round; after which the wheel was ratcheted continually round 300 times in the same direction, without disengaging the screw, when the teeth were found sufficiently indented. Now, it is evident, that, if the circumference of the wheel were even a whole tooth or ten minutes space greater than the screw would require, this error would, in the first instance, be reduced to  $\frac{1}{240}$ th part of a revolution, or two seconds and a half; and these errors or inequalities of the teeth were equally distributed round the wheel at the distance of 9 teeth from each other; but, as the screw in ratcheting had continually hold of several teeth at the same time, and as these were constantly changing, the above-mentioned inequalities soon corrected themselves, and the teeth were reduced into a perfect equality.

The piece of brass which carries the wire was now taken away, and the cutting-screw also removed, and replaced by the plane one of the same dimensions; on one end of its arbor was put the micrometer circular plate divided into 60, and numbered at every six divisions, as already stated; and on the other end was placed a ratchet-wheel of 60 teeth, seen in *fig. 6*, which is covered by the hollowed circle *d*, carrying two clicks, that catch upon the opposite sides of the ratchet, when the screw is to be moved forwards. The cylinder S, *figs. 5* and 9, turns on a strong steel arbor F, seen in *fig. 5*, which passes through, and is firmly screwed to the piece Y; this piece, for greater firmness, is attached to the screw frame G by the braces *v*: a spiral groove or thread is cut on the outside of the cylinder S, which serves both for holding the string, and also for giving motion to the lever J on its centre, *figs. 9* and 10, by means of a steel tooth *n* that works between the threads of the spiral. To the lever is attached a strong steel pin *m*, *fig. 10*, on which a brass socket *t* turns: this socket passes through a slit in the piece *p*, and may be tightened in any part of the slit by the finger-nut *f*: this piece serves to regulate a number of revolutions of the screw for each tread of the treadle R, seen in *fig. 1*. T, in *fig. 1*, is a brass box, containing a spiral spring: a strong gut is fastened and turned three or four times round the circumference of this box; the gut then passes several times round the cylinder S, *figs. 1* and 9, and from thence down to the treadle R. Now, when the treadle is pressed down, the string pulls the cylinder S round its axis, and the clicks laying hold of the teeth on the ratchet, carry the

screw round with it, till, by the tooth *n* working in the spiral groove, the lever J is brought near the wheel *d*, *fig. 6*, and the cylinder is stopped by the screw-head *x*, *fig. 9*, striking on the top of the lever J: at the same time the spring is wound up by the other end of the gut passing round the box T, *fig. 1*. Now, when the foot is taken from the treadle, the spring in the box unbending itself, pulls back the cylinder, the clicks leaving the ratchet and attached screw at rest till the piece *t* strikes on the end of the piece *p*, *fig. 10*; and the number of revolutions of the screw at each tread is limited by the number of revolutions that the cylinder is allowed to turn back before the stop strikes on the piece *p*. When the endless screw is moved round its axis with a considerable velocity, it will continue that motion a little after the cylinder S is stopped; to prevent which angular motion, the angular lever *n* was made, that when the lever J comes near to stop the screw *x*, it, by a small chamfre, presses down the piece *x* of the angular lever; this brings the other end *n* of the same lever forwards, and stops the endless screw by the steel pin *u* striking on its top; the foot of the lever is again raised by a small spring pressing on the brace *v*.

Two clamps D, *fig. 13*, connected by the piece *a*, *fig. 1*, slide, one on each arm of the frame L, and may be fixed at pleasure by the four finger-screws *e*, which press against steel springs, to avoid spoiling the arms; the piece *q*, *fig. 13*, is made to turn without shake between the two conical pointed screws *f, f*, set fast by the finger-nuts N, N. The piece M is made to turn on the piece *q*, by the conical pointed screws resting in the hollow centres *e, e*. As there is frequent occasion to cut divisions on inclined planes, for that purpose the piece *g*, in which the tracer or dividing point is fixed, has a conical axis at each end, which turn in half holes; so that when the tracer is set to any inclination, it may be fixed there, by tightening the steel screws  $\beta\beta$ .

Subsequently to the time of Mr. Ramsden's dividing engine being constructed, Mr. Edward Troughton constructed one to answer the same purpose, which it does in the most perfect manner; and it was our intention to have described it also in this place, but on application to him for permission to inspect its parts and manner of operating, we were sorry to learn that he has pledged himself to give an account of it himself in another work.

ENGINE (by Ramsden) for cutting the Screws of the circular Dividing-Engine.—We mean not to enter here into the history of the screw-engine, as it may be, and has been applied to various purposes, but to describe the engine made and used by Mr. Ramsden for making the individual screws which he used for ratcheting his engine for dividing circles, &c., and for measuring the angular distance on his circle when ratcheted. This apparatus, indeed, may be considered as an appendage to the other, and therefore ought to be introduced in this place. *Fig. 1*, of *Plate X*, of *Engines*, represents this engine as seen from one side of reduced dimensions; and *fig. 2*, the same as seen from above, of the same dimensions. A represents a triangular bar of steel, to which the triangular holes in the pieces B and C are accurately fitted, and may be fixed on any part of the bar by the screw D. E is a piece of steel whereon the screw is intended to be cut, which, after being hardened and tempered, has its pivots turned in the form of two frustra of cones, as represented in the drawings of the dividing-engine. These pivots were very exactly fitted to the half holes F and T, which were kept together by the screws Z. H represents a screw of untempered steel, having a pivot I, which turns in the hole K. At the other end of the screw is a hollow centre, which

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receives the hardened conical point of the steel pin M. When this point is sufficiently pressed against the screw, to prevent its shaking, the steel pin may be fixed by tightening the screws Y. N is a cylindrical nut, moveable on the screw H, which, to prevent any shake, may be tightened by the screws O. This nut is connected with the saddle-piece P, by means of the intermediate universal joint W, through which the arbor of the screw H passes. A front view of this piece, with a section across the screw-arbor, is represented at X, *fig. 3*. This joint is connected with the nut by means of two steel slips S, which turn on pins between the checks T, on the nut N. The other end of these slips S turn in like manner on pins *a*. One axis of this joint turns in a hole in the cock *b*, which is fixed to the saddle-piece, and the other turns in a hole *d*, made for that purpose in the same piece on which the cock *b* is fixed. By these means, when the screw is turned round, the saddle-piece will slide uniformly along the triangular bar A. K is a small triangular bar of well-tempered steel, which slides in a groove of the same form on the saddle-piece P. The point of this bar or cutter is formed to the shape of the thread intended to be cut on the endless screw. When the cutter is to take proper hold of the intended screw, it may be fixed by tightening the screw *e*, which presses the two pieces of brass G upon it. Having measured the circumference of the dividing-wheel, it was found to require about one thread in a hundred, coarser than the guide-screw H. The wheels on the guide-screw arbor H, and that on the steel arbor E, on which the screw was to be cut, were proportioned to each other to produce that effect, by giving the wheel L 198 teeth, and the wheel Q 200. These wheels communicated with each other by means of the intermediate wheel R, which also served to give the threads on the two screws the same direction. The saddle-piece P is confined on the bar A by means of the pieces *g*, and may be made to slide with a proper degree of tightness by the screws *n*.

*ENGINE for cutting the Screw of Ramsden's Engine for dividing Straight Lines.*—The exactness of the straight line engine, as made by Ramsden, depends very much on the correctness of the endless screw, which requires some properties that are not absolutely necessary in the endless screw for the circular engine. In that, as there are but a few threads of the endless screw engaged in the teeth of the wheel; it required only that those threads should have a similar inclination to the axis of the screw all round; but in the straight-line engine, where the whole length of the screw is engaged in the moveable plate, it is necessary that the distances also between the threads should be precisely the same throughout the whole length of the screw: as this is effected in a manner in some respects different from the mode of cutting the screw we have just described, we shall subjoin it here, that the reader may take a comparative view of the two methods adopted, by that great artist Ramsden. In *fig. 1*, of *Plate XI*, of *Engines*, is a plan of the engine for cutting the screw for dividing straight lines; and in *fig. 2*, is an elevation of the same. The section, as given in the original account published in 1779, does not seem to be necessary for explaining the engine, and is therefore omitted in our account. A, in *fig. 1*, represents a strong circular plate of brass, having its edge ratched, as described in our account of the circular dividing-engine; on its centre is firmly fixed the pulley B by four screws, having a groove turned on its cylindrical part, perfectly concentric with the plate A. C, in *fig. 2*, is a steel axis two feet long, terminating in a point, whereon it rests; the upper part of the axis being firmly screwed to the plate A, and turning in the collar D.

E represents an endless screw, *fig. 1*, which being turned on its horizontal axis, moves the circular plate A round its centre: F is a circular divided small plate, or micrometer-head, which may be turned with or without the endless screw; and on the other end of this screw-arbor is a large pinion *a*, with levelled teeth on its edge, together with the winch X to turn it by. G, seen in both figures, is a triangular bar of steel, which passes over the circular plate A, and is firmly screwed to the frame of the engine at H, *fig. 1*, and I, *fig. 2*. K is a piece of steel forming the arbor of the screw intended to be cut, having a wheel L, on one end acting with the pinion *a* before-mentioned. M and N, *fig. 1*, are two strong pieces of brass, in which the arbor just mentioned turns, and are firmly fixed to the triangular bar G, by means of the screws *n, n*, seen at I, in *fig. 2*. O, seen in both figures, is a piece of brass that slides on the triangular bar G, the two extremities of which are made exactly to fit the bar; it slides regularly thereon, and is prevented from rising by the two spring pieces *c, c*; near one end of the piece O is an angular groove *q*, *fig. 1*, that holds the tool by which the threads are cut, and is pointed with a diamond, in order to cut the steel after it is hardened and tempered: the cock *w* serves to fasten the tool, which may be set to take proper hold on the steel by turning the finger-screw *s*, and is fixed there by the screw *v*.

To make a perfect screw, it is only required to give the point that cuts the threads an uniform motion parallel to itself, and also to the axis of the intended screw, and that this motion be proportioned to the revolutions of the intended screw as the number of threads may require. To effect this, a piece of thin tempered steel *t*, exactly of the same thickness throughout, is fastened to the slide O at *r*; the other end of the spring being fastened to the pulley B in the groove: now while the circle A, with the pulley, is turned round its centre by turning the endless screw to the right hand, the spring *t* draws the slider O, with the attached cutter *q*, along the triangular bar; at the same time the steel-arbor K of the screw to be cut revolves by means of the communication of its wheel L with the revolving pinion *a*.

The screw, E, of the circular plate has 20 threads per inch, therefore if the number of teeth on the pinion, *a*, be to the number in the wheel L, as the number of teeth on the circular plate, A, is to the number of 20ths of an inch round the circumference of the pulley B, allowing for part of the thickness at the spring *t*, the spaces between each of the threads of the screw to be cut will be also 20ths of an inch. The size of the pulley, B, was determined thus: the endless screw, E, being disengaged from the circular plate A, the slider, O, was drawn back till the end of it came nearly to the piece M; the endless screw was again engaged in the plate A; then having two very small dots on the slider O, set off parallel to one side, at exactly five inches distance from each other, the slider was moved by turning the endless screw E, till one of its dots was bisected by a small silver wire fixed across a hole made in a thin piece of brass fast to the piece N; then O on the micrometer head, F, being put to the index without moving the screw, the pulley was tried and reduced, till just 600 revolutions of the endless screw, E, brought the second dot to be exactly bisected by the fixed wire. These bisections were examined by a lens of half an inch focus, set in a small brass tube, that was fixed perpendicularly over the wire.

*ENGINE for dividing straight Lines, by Ramsden.*—When Mr. Ramsden had succeeded in dividing sextants, &c. by his circular dividing engine, and was rewarded by the honourable Board of Longitude, he turned his mind towards

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wards the contrivance of an engine that would divide straight lines into any number of assignable parts, and that might be useful in laying down with extreme accuracy the lines of fines, tangents, secants, &c. on sectors and plane scales. The project was realized, and the account was ordered to be published by the Board of Longitude, in the year 1779. We do not find, however, that the original model, which we come now to describe, has been found desirable to copy by succeeding mathematical instrument makers: more simple and less expensive means have been adopted, which are found to answer practically as good a purpose. A beam-compass, aided by proper tables, is quite accurate enough for the nicest purposes of dividing unequal, as well as equal, divisions by bisection; and a pattern once carefully laid down can be used, for transferring the divisions on the common cases of instruments, with greater facility than the engine itself can be worked; and, provided great care be taken to prevent the parallax of the transferring point, the accuracy will be sufficient for all ordinary uses. This engine, which professes to divide any line without an error of  $\frac{1}{10000}$ th of an inch, has its principal parts represented in *Plate XII. of Engines*; where *fig. 1*, represents a plan of the dividing portion, as seen from above; *fig. 2*, an elevation of the same seen across; and *fig. 3*, the under side of *fig. 1*, when turned up. The original account contains some sections, which are more useful for the workmen as patterns, than for a general description, which may dispense with them altogether. *A*, in *fig. 1*, is a strong brass plate, 27 inches long, 4 broad, and  $\frac{1}{7}$ ths thick; worked exceedingly flat, and of the same thickness throughout, with its two edges parallel. One of these edges is ratched, or cut into teeth, of which there are just 20 in an inch, and is moved by an endless screw, containing just 20 threads in an inch, which actuates the teeth. (See *ENGINE for cutting the Screw of Ramsden's straight-line Engine*.) Each revolution of the endless screw round its axis will move the plate  $\frac{1}{1000}$ ths of an inch along an iron frame, hereafter to be described. A micrometer head is fixed at one end of the screw arbor, divided into 50 divisions, which, by means of a vernier subdividing into 5 parts, measures  $\frac{1}{10000}$ ths of an inch along the frame. Any rule or other instrument may be fastened on this plate, and may have a line drawn on it divided by a point or tracer, fixed in a proper frame, whereby it has a rectilinear motion without any lateral shake. When lines are to be divided by divisions not commensurable with English inches, which constitute the scale, the line to be so divided may be laid down, not parallel to the plate *A*, but obliquely, so as to make an angle with it, or become the hypotenuse line of a right-angled triangle; which line, by calculation, shall be to the base as the denomination of measure, when longer, is to the English inch; that is, as the secant is to the radius of the triangle, provided the tracer draws lines at right angles to the side of the plate; but if the traced lines be at right angles to the line to be divided, then the divisions on that line will be shorter than they would be on a parallel line of the plate, and in the proportion of the co-sine of the angle of inclination to radius. In order to adjust the inclination of a ruler laid on the plate *A*, two sectoral portions of a circle are laid down on one of its ends, with an extent from the point *J*, near the fixing screws on the edge of this plate. The outer sector is divided into proper degrees, and is numbered from 1 to 9, which degrees are subdivided into 6, or 10 minutes spaces; but the inner sector is divided into the proportion of the co-sines to radius 10,000, and its divisions are numbered 10, 20, 30, &c. to 140. The use of this contrivance will be best understood by an example: for instance, if a line of

$9\frac{1}{2}$  inches were to be divided into the same number of divisions, and in the same manner as if it were 10 inches long exactly; put the ruler to be divided to the cutting frame, hereafter described, and turn the handle, *T*, that moves the apparatus, till the same edge of the ruler cuts the central point *J*, and the first division from the *O* of the inner sector; then screw the ruler fast to the plate *A*, and when it has moved ten inches in its own direction, the whole length of the divisions on the line divided will be only  $9\frac{1}{2}$  inches, though the divided spaces will be respectively equal among themselves. It is not necessary for us to particularize the precautions taken, in making all the spaces of the teeth ratched equal to each other, during the act of ratching, which was done with a notched screw: this was done by means of points previously made and examined, with a wire at every 16 revolutions of the screw, till the teeth were a little indented to guide the screw along the whole line by continual revolutions, as was the case in the circular dividing instrument, more particularly described, because found more particularly useful. *B*, in *fig. 1*, is a strong iron frame, 43 inches long, having two edges, *a* and *b*, rising half an inch above its surface; these two edges are made very straight, and are in the same plane; the inside of the edge *a* is also made as straight as possible. The plate, *A*, slides on the two edges of the iron frame; beneath it are two springs, *c, c*, seen in *fig. 3*, each fastened at the extreme ends to the plate *A*, by the screws, *s, s*; at the other end of each spring is a roller, *e*, of tempered steel, turning on an axis in these springs; there is also a third roller, *d*, of tempered steel, let into the iron frame, not seen, near where the threads of the endless screw act; this roller has a long axis, so situated that it may be raised or depressed as occasion may require, to bear the weight of the plate *A*, and rule or instrument placed on it. *C*, in *figs. 1* and *2*, is the endless screw of tempered steel, with pivots of two sorts of inverted cones, similar to those described in the engine for dividing circles, &c. which turn in adjustable half holes in brass cocks screwed to the iron frame. *G, G*, in *fig. 3*; are two small steel frames turning on centres, *k*, fastened to the under side of the plate *A*, and equidistant from the edge of it; in each frame is a roller, *y*, of tempered steel, turning very concentric with their pivots, and exactly of the same diameter. The two small frames are connected together by the long brass bar *E*, which turns on a stud in each frame, and which preserves its parallelism, on the principle of a common parallel ruler. This apparatus serves to press the edge of the plate, *A*, with a motion parallel to itself against the threads of the endless screw. On the end of the plate, *A*, is a spring of tempered steel, acting as a bent lever. The spring end of this lever has a ketch which passes under the head of the stud *l*, that is on the end of the connecting piece *E*. While the other end of the lever is pressed gradually down towards the plate *A*, by turning the finger-screw *F*, the connecting piece, *E*, is drawn forward, so that the steel rollers, borne by the springs *T*, in *fig. 3*, pressing against the edge, *a*, of the iron frame, in *fig. 1*, may force the side of the plate against the endless screw.

Besides the micrometer head, already named, the arbor of the dividing screw, which has its threads similar to those of the notched ratching screw, has at its opposite end two sets of ratched wheels; one set for turning the screw, and the other set for stopping it at the proper times. These sets are each composed of three wheels, of which one has 32 teeth, another 48, and the third 50, which afford the means of subdividing the inch into spaces of different denominations; those wheels used in stopping the screw are ratched, with the teeth pointing in a contrary direction to those

those of the wheels for putting it in motion. I represents a cylinder of brass, having on one end two steel rings, *a* and *b*, with their contiguous edges cut into ratched teeth, in contrary directions, so as to fit each other as seen in the figure; on one of these rings is an index, and the other has its teeth numbered 10, 20, &c. up to 50; the other end of the cylinder is made hollow, and contains one of the sets of ratched wheels, already named. There are two slits opposite each other, pierced through the hollow part of the cylinder *W*; in each of which slits is a click turning on an axis, and pressed into the teeth of the ratched wheel by a small spring; these clicks may be moved along their axis, so as to catch in any one of the three ratched wheels, and may be fastened at that place by a small tightening screw *s*. The cylinder *I*, with the clicks, &c. turns on a steel axis, attached to the piece *K*, in a line with the axis of the endless screw. Motion is given to this cylinder round its axis by a piece of catgut, which hath one end fastened to the ratched ring *b*; and the other end, after passing four or five times round the cylinder, is fastened to a treadle, and, on pressing the treadle down, the clicks, *s*, catch in the teeth of one of the ratched wheels; by which contrivance the cylinder *I*, together with the endless screw, is turned round its axis, and its motion carries the plate, *A*, along the iron frame, and at the same time winds up the spiral spring *u*; but on releasing the treadle, the said spring unbends itself, the clicks quit the ratched wheel, and leave the endless screw at rest, whilst the cylinder, *I*, turns in an opposite direction, and raises the treadle to its former situation. *V*, in *fig. 2*, is a small square bar of steel, having both its extremities cylindrical; these cylinders move in holes lined with hardened steel, one in the piece *D*, and the other in the piece *K*. This bar carries three different pieces, which are of tempered steel; the middle one, *t*, is made to lie in the interval between the threads of the screw cut on the cylinder, and passes nearly half round its circumference: it is kept in the threads by a spring, *e*, that presses on a piece, *g*, screwed to the iron frame; this piece being attached to the bar, *V*, by a screw, turning the cylinder, *I*, on its axis, will give a longitudinal motion to the bar *V*. The upper end of the piece *f*, *fig. 2*, is formed into a hook, and may be set to catch in the teeth of any of the ratchet wheels, and then be fastened to the bar, *V*, by a screw *i*; towards the other end of the bar is a piece *j*, which serves to stop the cylinder in turning back, so as to limit the number of revolutions and parts of a revolution required, and is fastened to any required place on the bar, *V*, by the finger-screw *s*.

When the engine is used, the treadle is pressed down, and the catgut turns the cylinder *I*; in the mean time, the piece, *t*, moves along the thread till a stud, *r*, on the cylinder, striking on the top of the curved piece *t*, bends the spring *e*, until that piece rests on the piece *g*; by bending this spring, the square bar is turned a little on its axis, and pulls the hook, *f*, into the teeth on the ratched wheel *R*: then the treadle being released, the spiral spring turns back the cylinder till the piece, *j*, is brought under the stop on the ratchet ring *b*. The parts of a revolution are regulated by setting the number required on the ratchet ring, *b*, to the index on the fixed ring *a*; each of the teeth answers to the motion of  $\frac{1}{100}$ th of an inch of the plate *A*; and the number of revolutions, each of which moves the plate, *A*,  $\frac{1}{10}$ ths of an inch, is regulated by setting the piece, *j*, on the bar. *I*, in *fig. 1*, represents the steel frame in which the tracer is fixed; this frame turns between the conical points of two screws, *n, n*, of tempered steel, which are screwed in the frame *Q*, *fig. 2*; there are also two similar

screws in the same frame *Q*, at *m, m*; the points of these screws, which are also of tempered steel, turn in conical holes in the piece *P*; by means of this parallel motion, the tracing point, by which the dividing lines are cut, will always describe the same line without any lateral bending; the tracer is put on the hole in the axis *b*, *fig. 1*, and is fixed there by the four tightening screws, *f*, that press the holding piece, *e*, against the flattened part of the axis of motion. This small axis, which has its pivots formed of double cones, turns between half holes, and may be fixed when the tracer is set to any required inclination, by tightening the screws of pressure, *s, s, s, s*. Besides these parts of the engine, there is a brass ruler made as an appendage for setting the line to be divided in its true situation, but is not necessary to be particularly described: this ruler may be set parallel to the edge of the plate *A*, or to any angle of inclination, by turning the handle *T*, which moves the piece *P*, with the cutting frame and ruler, on the centre *x*; and the required position may be rendered permanent by tightening the capstan screw *p*.

*ENGINE-Shaft*, in *Mining*, is generally applied to the shaft or well wherein the pumps are erected for freeing a mine of its water; but in districts where the mines are relieved of water by soughs, as in the mountainous part of Derbyshire, it is common to find the shafts at which they draw ore by a horse-gin, called the engine-shaft, and the gin itself an engine.

*ENGINE to draw Fuzes*, in *Gunnery*, consists of a wheel with a handle to it, to raise a certain weight, and to let it fall upon the driver, by which the strokes become more equal.

*ENGINE to draw Fuzes* has a screw fixed upon a three-legged stand, the bottom of which has a ring to place it upon the shell; and at the end of the screw is fixed a hand-screw, by means of a collar, which, being screwed on the fuze, by turning the upper screw, draws out or raises the fuze.

*ENGINEER*, or *ENGINEER*, in its general sense; is applied to a contriver or maker of any kind of useful engines or machines.

In its more proper sense, it denotes an officer in an army or fortified place, whose business it is to contrive and inspect attacks, defences, works, &c. The term engineer is said to be of modern date, and to have been first used in the year 1650, when one Cap. Thomas Rudd had the title of chief engineer to the king. In 1634 an engineer was called camp-master general, and sometimes engine-master, being always subordinate to the master of the ordnance.

An engineer should be an able and expert mathematician, particularly versed in military architecture and gunnery; being often sent to view and examine the places intended to be attacked; to choose out and shew the general the weakest place; to draw the trenches, assign the places of arms, galleries, lodgments on the counter-scarp and half-moons; conduct the works, saps, mines, &c. and appoint the workmen their nightly task; he is also to make the lines of contravallation; with the redoubts, &c.

Under the establishment of the office of his majesty's ordnance in England, the corps of *royal engineers* consists of one colonel in chief, one colonel in second, three colonels commandant, six colonels, 12 lieutenant-colonels, 27 captains, 28 second-captains, 55 first-lieutenants, 28 second-lieutenants, an inspector-general of fortifications, his deputy brigade-major, adjutant, and quarter-master.

The establishment of the corps of *invalid engineers* comprehends a colonel, lieutenant-colonel, captain, captain-lieutenant and captain, first-lieutenant and second-lieutenant.

The corps of *royal engineers* in Ireland consists of a director, colonel, lieutenant-colonel, major, captain, captain-lieutenant, and captain, and two first-lieutenants. See **ORDNANCE**.

**ENGINEERS, Civil**, a denomination which comprises an order or profession of persons highly respectable for their talents and scientific attainments, and eminently useful under this appellation, as the canals, docks, harbours, light houses, &c. amply and honourably testify. This order of artists is said to have commenced in this country about the year 1760, at which period the advancement of the arts and sciences was singularly rapid. In 1771, Mr. Smeaton, so well known in this department of science, projected and established an association, or society of engineers. During an interval of 20 years, the number of members of this society increased to 65, of whom 15 were real engineers, and the residue being composed either of amateurs, or of ingenious workmen and artificers. In May 1792 this society was dissolved in consequence of an unpleasant circumstance, which had interrupted its harmony; but a renewal of it, under a better form, was soon intended, though not accomplished during the life-time of Mr. Smeaton. His death happened in October 1792, and the first meeting of the new institution, entitled "The Society of Civil Engineers," was held on April 15, 1793, by Mr. Jessop, Mr. Mylne, Mr. Rennie, and Mr. Whitworth. According to the new constitution of the society, it is divided into three classes. The first class, as ordinary members, consists of real engineers. The second class, as honorary members, is composed of men of science, and gentlemen of rank and fortune, who have attended to the subject of civil engineering. The third class, as honorary members also, consists of artists, whose professions and employments are connected with what is called civil engineering. The meetings are held at the Crown and Anchor, in the Strand, every other Friday, during the session of parliament. See Reports of the late Mr. John Smeaton, F.R.S. &c. vol. i. 4to. 1797.

**ENGISOMA**, from *επισημα*, to draw near, in *Surgery*, an instrument formerly used by surgeons in cases of fractures of the skull. Hence, the word has been applied to such fractures of the cranium as are attended with a depression of the bone in the middle, so as to produce pressure on the membranes of the brain.

**ENGLAND**, in *Geography*. The southern, most opulent, and most important part of Britain, has been distinguished among European nations, ever since the days of venerable Bede, by the appellation of "Anglia," or England; which has been generally ascribed to the Angles, who conquered and took possession of a considerable part of the country. (See **ANGLIEN**, **ANGLES**, and **CimbriC CHERSONESUS**.) England is bounded on the east by the German ocean; on the south by the English channel; on the west by St. George's channel; on the north by the Cheviot hills, by the river Tweed, and an imaginary line extending south-west to the Frith of Solway. The extent of England and Wales is estimated at 49,450 square miles, and if we allow the population to be 9,500,000, the number of inhabitants to a square mile will be 192. The original population of England is involved in obscurity; but as far as it can be traced by any authentic records of history, it seems to have consisted of a tribe of Celts (see **CELTS**), denominated Gael or Southern Celts, and distinguished by the Welsh under the appellation of "Guydels," who migrated hither from the nearest shores of France and Flanders. These southern Celts were compelled to evacuate the country, and to retire to Ireland, by another tribe, composed of the Cimbri of the

north, whence the modern Welsh derive their origin and name of Cymru. The Cimbri, or Northern Celts, were displaced by the Scythians, or Goths, who, at a period long preceding the Christian era, settled in that part of Gaul which is nearest to Great Britain, and acquired the provincial denomination of Belgæ. (See **BELGÆ**.) We learn from Cæsar (lib. v. c. 10.) that the primitive inhabitants were driven into the interior parts of the country by Belgic colonies, which occupied the regions on the south-east, probably about three centuries before the Christian era. These Belgæ seem to have constituted the chief ancestors of the English nation; but during a subjection of four centuries to the Roman power, after Britain was rendered a Roman province by the talents and virtue of Agricola, (see **AGRICOLA**,) they lost their primitive valour, and were unable to contend with their fierce invaders from Scotland and Ireland. In these circumstances the continent supplied them either by accident or at their own request, with new emigrants. The Jutes arrived in the year 449, and about the year 460 founded the kingdom of Kent. The Saxons first appeared in 477, and the kingdom of the South Saxons commenced about this period. The West Saxons arrived in the year 495, and the East Saxons in the year 527. The Angles, who gave their name to the country, were led by the valiant Ida to Bernicia, in the year 547. The East Angles took possession of Norfolk in 575; and the coasts on the south and east were over-run by them. Hence they soon penetrated into the interior of the country, and in 585 founded the kingdom of Mercia, which was the last of the heptarchy. (See **HEPTARCHY** and **SAXONS**.) The kingdom of Northumberland existed under its peculiar sovereign, the last of whom was Eric, till the year 950; and the three counties of modern Northumberland, Cumberland, and Westmoreland, were regarded at that period, when *Domesday-book* was compiled, as part of Scotland. Bernicia (which see) extended at one period to the Frith of Forth; but in the later Saxon times the boundaries of England on the north fell considerably within the present extent. On the west the Welsh were restricted by Offa's dyke, (see **DYKE**), which extended from the river Wye, through the counties of Hereford and Radnor, into that of Montgomery, where it entered North Wales. It afterwards passes by Chirk-castle to the river Dee, and terminates in the parish of Mold. During the Norman period, the northern limits of England were extended to their present circuit. Cumberland and Westmoreland were wrested from the Scots, and the provinces north of the Humber were completely incorporated. The dominion of the Danes commenced in the year 1016, but returned to the Saxon line in the year 1042. On the death of Edward the Confessor, the conquest, as it is called, under William the Norman, took place in 1066. (See **CONQUEST**.) For a farther account of the history of England, see **BRITAIN**, and the sequel of this article.

The antiquities of England are distributed by Mr. Pinkerton (*Geog.* vol. i.) into six classes, *viz.* those belonging to the primitive Celtic inhabitants; those of the Belgic colonies; those of the Romans; those of the Saxons; relics of the Danes; and Norman monuments. It is not easy, says our author, to discriminate the remains of the earliest inhabitants from those of the Druidic period, which he supposes to have originated with the Phœnician factories, established in wooden fortresses on the coast, which was the usual practice of commercial nations, when trading with a savage or barbarous race. The tenets of Druidism correspond, as he conceives, with the little that is known of Phœnician mythology, in the diffusion of which the missionaries of these refined people might be not a little zealous. However this

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be, the ancient authors, from whom we derive our only authentic information concerning the Druids, minutely describe their religious rites; but they are altogether silent concerning any monuments of stone being used among them. On the contrary, they mention gloomy groves, and spreading oaks, as the only scenes of the Druidic ceremonies. (See DRUIDS.) Nevertheless, our learned antiquarian, Borlase, refers to the class of Druidic monuments such as follow, viz. single stones erect; rock idols and pierced stones; rocking-stones used as ordeals; sepulchres of two, three, or more stones; circular temples, or rather circles of erect stones; rock-basins, supposed to have been used in the expiations of the Druids; and caves, used as places of retreat in time of war. But Mr. Pinkerton observing, that most of these relics may be found in Germany, (where no Druids existed,) and Scandinavia, thinks it hazardous to pronounce whether they be Gothic or Celtic. It is most probable, he imagines, that the earliest inhabitants, like others who exist in the infancy of society, made use of wood, not stone, in their religious, as well as in their domestic structures. He thinks it most reasonable to refer monuments of this kind to a more advanced stage of society, when the Belgic colonies introduced agriculture, and had made somewhat farther progress in the rude arts of barbarism. See BARROW and CROMLECH, STONE-HENGE, &c.

The Roman relics are amphitheatres, castles, ways, or roads, pavements, hypocausts, walls, inscriptions, altars, &c. &c. which are described under these articles respectively; to these we might add coins, gems, weapons, ornaments, and the like. The Saxon antiquities in England are chiefly edifices, sacred or secular, castles, vaults, shrines, illuminated manuscripts, &c. The relics of the Danes are castles, stones with Runic inscriptions, and camps, which were constructed in a circular form, like those of the Belgæ and Saxons, while those of the Roman armies are distinguished by their square form. The Norman monuments are reputed to commence after the conquest, and to extend to the 14th century, when that which is called the rich Gothic began to appear. This latter was supplanted, in the 16th century, by the mixed, which in its turn yielded to the Grecian. The Norman style in general far exceeds the Saxon in the size of the edifices, and the decorations of the parts. The churches became more extensive and lofty; and though the windows retain the circular arch, they are larger and more diversified, the circular doors are festooned with more freedom and elegance; and uncouth animals begin to yield to wreaths of leaves and flowers. The solitary keep, or tower, of the Saxon castle, is surrounded with a double wall, inclosing courts and dwellings of large extent, defended by turrets and double ditches, with a separate watch-tower, called the Barbican. Among others the cathedrals of Durham and Winchester may be mentioned as venerable monuments of Anglo-Norman architecture; and the castles are numerous and well-known. What is called the Gothic, or pointed arch, is generally supposed to have first appeared in the 13th century; and in the next it became universal in religious edifices. The windows diffused to great breadth and loftiness, and divided into branching interstices, enriched with painted glass, the clustering pillars of excessive height, spreading into various fret-work on the roof, constitute, with decorations of smaller note, what is called the rich Gothic style, visible in the chapel of King's college at Cambridge, and many other grand specimens in this kingdom. The spire corresponds with the interior; and begins, about the 13th century, to rise boldly from the ancient tower, and diminishes from the sight in a gradation of pinnacles and ornaments. See GOTHIC.

England is now distributed into 40 shires or counties. See COUNTY and SHIRE.

	Population.	Chief Towns.
Six Northern Counties.	Northumberland,	157,101 Newcastle.
	Cumberland,	117,230 Carlisle.
	Durham,	160,361 Durham.
	Yorkshire,	563,953 York.
	Westmorland,	41,617 Appleby.
Four bordering on Wales.	Lancashire,	672,731 Lancaster.
	Cheshire,	191,751 Chester.
	Shropshire,	167,639 Shrewsbury.
	Herefordshire,	81,191 Hereford.
Twelve Midland.	Monmouthshire,	45,582 Monmouth.
	Nottinghamshire,	140,350 Nottingham.
	Derbyshire,	161,142 Derby.
	Staffordshire,	239,153 Stafford.
	Leicestershire,	130,081 Leicester.
	Rutlandshire,	16,356 Okeham.
	Northamptonshire,	131,757 Northampton.
	Warwickshire,	208,190 Warwick.
	Worcestershire,	139,333 Worcester.
	Gloucestershire,	250,809 Gloucester.
	Oxfordshire,	109,620 Oxford.
	Buckinghamshire,	107,444 Aylesbury.
Bedfordshire,	63,393 Bedford.	
Eight Eastern.	Lincolnshire,	208,557 Lincoln.
	Huntingdonshire,	37,568 Huntingdon.
	Cambridgeshire,	89,346 Cambridg.
	Norfolk,	273,371 Norwich.
	Suffolk,	210,431 Ipswich.
	Essex,	226,437 Chelmsford.
	Hertfordshire,	97,577 Hertford.
	Middlesex, (capital excluded,)	535,329 London.
Three Southern.	Surry,	269,043 Guilford.
	Kent,	307,624 Maidstone.
	Suffex,	159,311 Lewes.
Four Southern.	Berkshire,	109,215 Reading.
	Wiltshire,	185,107 Salisbury.
	Hampshire,	219,656 Winchester.
	Dorsetshire,	115,319 Dorchester.
Three Southern.	Somerfeshire,	273,750 Taunton.
	Devonshire,	343,001 Exeter.
	Cornwall,	188,269 Launceston.

For a more particular account of each county, see the separate articles.

It is hardly necessary to mention, that London is the capital of England, or in this place to enumerate its principal towns, which are described under their several appellations. Canterbury and York are the sees of archbishops: Oxford and Cambridge are universities. The principal rivers of England are the Thames, the Severn, the Humber, the Mersey, &c. which feed respectively. For an account of our inland navigation, see CANAL; and for our bridges, see BRIDGE. The mountains with their productions, will occur under that article. For the climate, see BRITAIN; and of the soil, and agriculture, &c. an account will be found under the name and description of each county; and under the appropriate terms of cattle, dog, hog, horse, sheep, goats, &c. and wheat, rye, barley, oats, apples and cyder, pears and perry. Our forests (see FOREST) anciently abounded in stags and rein-deer, as the cultivated lands now do with sheep and cattle. The principal wild animals, wolves and bears having been totally destroyed,

destroyed, are the fox, wild-cat, badger, fitchet, martin, otter, squirrel, &c. Among our birds of prey may be reckoned the black eagle, and many kinds of hawks. Our smallest bird is the gold-crested wren, and our largest the bustard. Our poultry seem to have been originally derived from Asia; our peacocks from India; our pheasants from Colchis; the guinea fowl from Africa; and our turkeys from America. One of the most singular of our water-fowl is the long-legged plover, and the most useful is the mallard or wild duck, chiefly abounding in the fens of Lincolnshire. The reptiles of England are the coriaceous tortoise, frogs, toads, and several kinds of lizards; among our serpents are the viper, which alone is venomous, the ringed snake and the blind worm, all of which, together with other species, are enumerated and described in their proper places. Our edible sea-fish are very numerous; among which we may reckon the turbot, dorie, seal, cod, plaise, smelt, mullet, &c. Herrings and mackarel extend to most parts of the kingdom; but pilchards are restricted to the coasts of Cornwall. The whale seldom appears on the English coast, nor the dolphin; but the porpoise is not uncommon. Our principal river fish comprehend the salmon and trout. The lobster is found on most of the rocky coasts, particularly of Scarborough. The crawfish, muscle and oysters, are abundant. The flora of Britain contains as great a variety of genera and species as any other country of equal extent; and those that are most worthy of notice, on account either of their variety or utility, or other peculiar circumstances attending them, are enumerated and described under their proper heads. Our native fruits are few, but others have been introduced and our own improved, so that plumbs, cherries, peaches, nectarines, apricots, figs, grapes, &c. are by the skill and care of the English gardeners raised in the greatest plenty and variety. The oak and beech are natives of England: the elm is probably an exotic; but there are few plants in any part of the known world, which have not been introduced into our plantations, nurseries, green-houses, and hot-houses.

The constitution of England is a limited monarchy counterpoised by two senates, one of hereditary peers, the other of representatives chosen by the people. (See CONSTITUTION, CROWN, KING, COMMONS, PEERS, PARLIAMENT.) For an account of the judicature of England, we refer to the articles JUDGE, JURY, COURT, CIRCUIT, JUSTICE, SHERIFF, &c. The established religion of England is that of the reformed church under the administration of the king, as supreme head, archbishops, bishops, deans, archdeacons, rectors, vicars, curates, &c. See each of these titles. See also CHURCH, CLERGY, CONVOCATION, Ecclesiastical COURTS, &c. Besides those who are members of the established church, England abounds with dissidents or dissenters of various descriptions. See these terms, and also INDEPENDENTS, PRESBYTERIANS, BAPTISTS, QUAKERS, METHODISTS, PAPISTS, &c. For the army and navy of England; its manufactures and commerce; its land and revenue; its population; and various other particulars; see BRITAIN, and the appropriate articles in this work.

ENGLAND, *history of*. The principal events belonging to the history of our country will be found under the names of the several kings who have reigned over it. To the articles attached to those names we might refer generally for a compressed detail of all the changes and revolutions to which England has, at its several periods, been subject; but in conformity to the plan sketched out in the article BRITAIN, we must in this place give a very brief outline of the history of England, from the Norman conquest to the accession of James I.; and likewise the history from that period to the present times. After the conquest, our history is represented

in so clear a light, as leaves little either obscure or uncertain. The only difficulty we shall find will be in condensing into a small space the leading facts that are not immediately connected with the lives of the sovereigns.

The Saxon monarchy (see SAXONS) had continued for more than six hundred years: during which, as we shall hereafter see, they enforced many of their own laws and customs, though they readily adopted others congenial to the country; and which were derived, as well from the Romans, as the ancient Britons, and which they found in the island upon their invasion of it. The habits and manners of this race were melted down and amalgamated with those of Norman institutions. Every thing was changed; the laws in some respects were improved, but there was still little taste for literature and science. From this period, however, we are to date the commencement of certain institutions which, though they required centuries to ripen into maturity, have nevertheless given this country a superiority over every other in the civilized world. The variety of dispositions of several foreign countries being imported into our island, at length blended into one national character, celebrated for its courage, its love of freedom, and its pride.

Immediately after the victory of Hastings, the conqueror marched towards London, carrying before him a standard which had been blessed by the pope; and to this the clergy, as is usual, hastily resorted. The bishops and magistrates came out to meet him, and offered him the crown, which he had won by his intrigues and valour. They stipulated terms to which he readily acceded, being desirous of a sovereignty by the free choice of the people rather than as claimed by the power of the sword. Though he knew himself to be their conqueror, he desired to be thought their lawful king. William felt that he had power to enforce obedience, but affecting the voice of the people, they imputed his elevation to their own generosity; and when they felt themselves oppressed or aggrieved, did not scruple to resist his power by open revolt and insurrection. The English hated the Normans, and were jealous of the power which they sustained in the new government; they envied the wealth which went to enrich those who were truly denominated adventurers in a foreign land, and which was raised by loading the natives with heavy taxes, that in those times were with difficulty sustained. At length William saw he must act with energy if he meant to reign, and from this time he seems to have regarded England rather as a conquest, than a justly acquired dominion. He deprived the bishops of all judgment in civil causes, a right which they had assumed during the Saxon succession. He restrained the clergy to the exercise of their ecclesiastical power, and he endeavoured to abolish trials by ordeal and camp fight. See CAMP-FIGHT, and ORDEAL.

We do not intend to recount the acts of the kings of England in this article, but shall rather give a general sketch of the changes and revolutions in the constitution, government, manners, &c. of England. The changes introduced by the Norman conquest were not very material to the interests of the people. Those who occupied the lowest ranks, still continued in a state of slavery; and their numbers were rather increased than diminished. The conquerors treated their slaves with so much severity, that a contemporary writer declined to give a description of it, lest its inhuman cruelty should appear incredible to posterity. As the children of slaves were also slaves, this order of the people would have increased exceedingly; if many of them had not from time to time obtained their freedom, either by fidelity, or uncommon acts of diligence. In some cases the clergy had the power of granting freedom to slaves, and sometimes

the office was performed voluntarily by penitents, who hoped thereby to obtain the pardon of their sins. The middle ranks in society, that filled up the interval between the freedmen and the barons, were composed of different bodies of men, from whom, in process of time, the yeomanry and many of the gentry of England are descended. The inhabitants of towns and cities were generally of this middle rank. The barons were a numerous, opulent, and powerful body of men, and comprehended all the considerable proprietors of land in England. The accession of the Normans produced many important changes in the political circumstances of the people—in the tenures by which they held their lands—the services to which they were subjected—the magistrates by whom they were governed—the courts in which they were judged,—and the laws they were obliged to obey. These changes were chiefly owing to the establishment of the *feudal system* (which see) of police and government in England, by William, in the same state of maturity to which it had then attained in his dominions on the continent.

As the most important changes in the English constitution were made either in the reign of John, by the limitation of the severities of that system, it will not be necessary to dwell on the intermediate reigns. The succession of the crown of England, after the death of Edward the Confessor, became so unsettled, that it seemed to be the object of ambition to every bold invader, who possessed the slightest pretence, together with power and courage, to seize the glittering prize. The second William, Henry, and Stephen, are regarded as usurpers, and did, at the time, reign with a disputed title. This was a fortunate circumstance to the natives and their posterity, as it contributed not a little to raise them from that insignificance into which they had been depressed, to the preservation of what was left, and to the restoration of what had been lost of their ancient liberties. For the Norman barons, having estates both in Normandy and England, were anxious that the ducal and royal crown should rest on the same head, that they might enjoy their estates in both countries. Many of these barons therefore favoured the pretensions of Robert duke of Normandy, eldest son of William I., to the crown of England. This obliged his opponents William and Henry to have recourse to the native English, who were still formidable by their numbers, after all the losses which they had sustained. Hence they felt their own importance in the scale of being, and obtained for themselves certain rights and immunities which their sovereigns were ill disposed to grant of their own free will. Henry I. granted them a charter, which proved a model on which the famous charter of liberties in the reign of John was formed. He also promulgated a system of laws consisting chiefly of those of Edward the Confessor. Stephen, as his title to the throne was more disputed, was more liberal of his promises; but as he was less disposed to perform what he had bound himself to do, his whole reign was a scene of contention and civil war. At this period the civil law was brought into England from Rome, but not without considerable opposition on the part of the people, who were so much enraged against it, that whenever they met with a copy of the Roman law, they destroyed it with every mark of indignation. Henry II. conciliated the affections of his subjects by granting them a charter, confirming that of his grandfather Henry I. To this prince, whose reign was protracted to a great length, the country was indebted for many improvements in the law, as well in its administration, as in the forms and practice of the courts. At this period the clergy, who were screened from punishment on account of their profession, committed every species of crime, which

led (A. D. 1164,) to the enactment of the celebrated constitutions which had the effect of reducing the clergy to the rank of subjects. Still, however, justice was not always administered in those ancient times with wisdom and impartiality, partly owing to the ignorance of the judges, and partly to the prevalence of faction among the suitors of the courts. Nor was it an easy matter to procure relief from an iniquitous sentence pronounced by a baron or sheriff, on account of the great distance and unsettled state of the king's court, which constantly attended his person. To remedy this inconvenience Henry II. with the advice of a great council of his prelates, earls and barons, at Northampton, A. D. 1176, divided the whole kingdom into six circuits, and appointed three judges to hold courts in each of these, by a commission from the king, empowering them to hear and determine all causes not exceeding the value of one half of a knight's fee, unless the matter was of such importance or difficulty as to require the judgment of the king's court in the royal presence. These itinerant justices took an oath to administer justice to all persons with impartiality. They had also authority to judge in all criminal causes and pleas of the crown, and to transact a variety of other affairs for the public good. Under the reign of Richard, besides laws relating to the voyage of his fleet to the Holy Land, and those connected with commerce, were others of an excellent nature, in which he attempted to establish an uniformity of weights and measures over the whole kingdom, a thing greatly wanted, but which has not even yet been accomplished. The changes introduced by John have been recited under the article CONSTITUTION. The barons, who procured the famous charter, have been viewed as acting in two capacities, 1, as military vassals of the crown: 2, as subjects of the kingdom. They consulted their own interest in the first capacity, by the limitations of the rigours of the feudal tenures which they procured, and in which all who held lands by military services shared with them. They consulted their interest in the second capacity, by the amendments which they procured in the general police of the kingdom, in which all their fellow subjects were partakers. These amendments tended to remove or alleviate the several grievances of which the people in general complained; of these, the greatest and most important was, that the mere will and command of the sovereign were substituted in the place of law, and men were seized, imprisoned, stripped of their estates, outlawed, banished, and even destroyed, without the form of trial. Next to the substitution of arbitrary will in place of law, was the king's personal interference in law-suits depending before his courts, in order to interrupt or pervert the regular course of justice. These flagrant outrages at length wrought their own cure, and those who had tyrannized over the people were obliged to submit to their power.

The common, as well as the statute law of England, received considerable improvements in the reign of Henry III.; but his successor Edward I. was, as a general and legislator, equalled by few of the kings of England, and surpassed by none. He was satisfied with a moderate degree of power, and only laboured to render himself terrible to his enemies. The English, now incorporated with their fierce Norman conquerors, were no longer the tame consenting people they formerly appeared, but were always prepared to reason with that authority which could not easily be resisted. This spirit of opposition was tinged with cruelty: regardless of their own lives, the people did not seem very solicitous about the lives of others. Penal laws began to assume more rigour: in the times of William the Conqueror, it was a law, that no man should be punished with death; in the

the reign of Edward, that law was entirely laid aside, and several crimes were rendered capital. But what gave permanence to the reputation of this monarch, was the degree of power the people began to assume during this period. The clergy and barons he regarded as rivals; and to weaken their force, he gave authority to the commons: a law was enacted, by which no tax could be levied without their consent. On account of the many wise laws made in this reign, the monarch has been styled the English Justinian. Some of these statutes respected the church, and were intended to fet bounds to the power of the pope, the riches of the clergy, and the encroachments of the spiritual courts. Others were calculated for explaining, confirming, and enlarging the liberties which had been granted by the great charter. According to sir Matthew Hale, "the model of the common law, especially in relation to the administration of common justice between party and party, as it was rectified by this king, so in a great measure it has continued the same in all succeeding ages to this day; so that the mark or epocha we are to take for the true dating of the law of England, what it is, is to be considered, stated, and estimated, from what it was when this king left it. Before his time it was in a great measure rude and unpolished, in comparison of what it was thus polished and ordered by him, so hath it stood hitherto, without any great or considerable alteration." Edward made great efforts to reduce the whole island of Britain into one kingdom, governed by the same sovereign, and subject to the same laws; and with respect to Wales, he completely succeeded so as to introduce into it many of the English laws, customs, courts, and magistrates. His efforts to unite Scotland with England finally failed, and they served only to kindle a most violent and implacable animosity between the people of these two kingdoms, which gradually rendered their manners, laws, and customs more dissimilar than they had been in more ancient and amicable times. In the following reign, the Scots gained a complete victory over the greatest army ever sent into their country: but Edward III., the next in order of succession, contested, with Philip de Valois, his right to the kingdom of France. He therefore made an expedition into that country, and in the celebrated battles of Cressly and Poictiers, entirely destroyed the French army, and carried the monarch captive to England. See EDWARD III.

This wise prince never neglected to consult his parliament in affairs of moment. There are still extant his writs of summons to no fewer than seventy parliaments and great councils. The distinction between these assemblies was this; when he desired only the advice and assistance of his great barons who still possessed the greatest part of the power and property of the kingdom, he called the great council, consisting of all the great men, both of the clergy and laity, who held of the crown by barony, and were entitled to a particular summons. When he stood in need of the counsel and aid of all his subjects, he called a full parliament, which consisted not only of the barons spiritual and temporal, but also of the representatives of the inferior clergy,—of the smaller barons, or freeholders,—and of the citizens and burghesses of the kingdom; and those representatives of the clergy and laity, below the rank of barons, were called the spiritual and temporal commons.

Richard II. came to the crown a minor, and by his heroism in crushing the rebellion of Wat Tyler excited considerable expectation, which was completely disappointed by all the subsequent acts of his life. He submitted himself to evil counsellors, who took possession of his mind, and by their advice he sacrificed his best and ablest friends, and endeavoured to render himself despotic. But he was over-

powered, subdued, and obliged to resign his crown in favour of his cousin Henry duke of Lancaster; and this was the commencement of those contests between the houses of York and Lancaster, which for several years after deluged the kingdom with blood, and which nevertheless contributed in no small degree to give strength and consistency to the constitution. In the reign of Richard, Wickliffe began the great work of reformation. The deposed monarch was murdered with a pole-ax in Pontefract castle in the 34th year of his age, having reigned 22 years. His successor, Henry IV. surnamed Bolingbroke, had to contend with much internal trouble, and had so little claim to the sovereignty which he assumed, that conspiracies were speedily formed against him; these, however, were quelled and the leaders of them were executed. "If," says a good writer, "we compare the times at this period of our history with those of king John, or those of some reigns before him, we shall find a great change with respect to the insurgent barons. In the former period they made frequent insurrections, were often taken in open rebellion, and as frequently pardoned: but in this period they were seldom taken without suffering the utmost rigour of the law. This plainly shews how much the power of the barons was sunk in the course of a couple of centuries. This revolution of power is, notwithstanding, natural and obvious: as the people began to share the government with the nobles, the king was fixed upon as a third person to secure the balance, and both were contented to make him great from a jealousy of each other. Noblemen were therefore now executed, not as petty monarchs, but offending subjects, and none but kings were considered as exempt from penal laws."

In this reign the suppression of one rebellion seemed only to make way for another more formidable than the former, and more extensive in its consequences. The calamities of this period were not, however, confined to internal factions excited by discontented barons: the country was threatened with foreign invasions, and the clergy added not a little to the disturbance of the public peace. Ever since Wickliffe had published his opinions, his doctrine had been gaining ground, and the clergy were in dread of its prevailing to the exclusion of their system and to the ruin of their emoluments. Henry joined the clergy, considering that they might be made a powerful engine in establishing his usurped throne, and he recommended the parliament to the care of the church. At first the house of commons seemed reluctant in drawing the sword of persecution; they had not, however, vigour sufficient to oppose the power of the court and the clamours of the priests, but became instruments in their hands for the perpetration of much mischief. An act was passed for burning obstinate heretics; and William Sawfre, a follower of Wickliffe, was, by virtue of the king's writ, delivered to the mayor of London, and burned alive. This was the first martyr in England, on account of religion; but the fires, being once lighted, were not suffered to be extinguished. The clergy, under a mask of hypocrisy, and pretending a regard to truth, took every means that cruelty could suggest of establishing that degree of temporal power, which they had possessed three centuries before. They succeeded, but with this striking difference, that, as in the times of the Saxon heptarchy, their power was founded in the love of the people, in the present case it had its origin in, and was wholly maintained by, their fears. By these means, Henry surmounted all his troubles, and the kingdom enjoyed tranquillity. Towards the close of life he determined to embark upon an expedition to Jerusalem, as well to expiate, as he imagined, the sins of former years, as to induce his maker to protract the term of his life. His

increasing infirmities prevented him from executing his plan; and in his 46th year he resigned, by death, his crown to his son Henry V. During this reign, if allowance be made for the rancour of the priests, to whom the king was too subservient, the government may be said to have assumed a form and liberty; the distinction between the nobility and the people was rendered less considerable, and the magistrates were less arbitrary and less venal.

Henry V. was the great hero of his age, and the courage which he had manifested from his earliest years laid claim to the esteem and affection of the people over whom he was destined to reign. At this period, courage in the great was regarded as almost the only virtue: courage and superstition then made up the whole system of human duty. The clergy, notwithstanding their revenues, paid very little attention to the morals of the people, and were, if possible, less solicitous about their own character: the vices in which they openly indulged, and the passions to which they gave free reins, drew upon them a just degree of contempt; of which they avenged themselves, by having recourse to the engine of persecution. In this they were encouraged by the king, who, by not opposing, may be regarded as a participator of their crimes. One of the early acts of this reign was an attempt to suppress the doctrines of Wickliffe; and John Oldcastle, baron Cobham, was the principal sufferer in their defence. This excellent man was doomed to bear the most excruciating torments: he was hung up by the middle with a chain, and by a slow fire literally roasted alive. The deed was scarcely perpetrated when the king, probably disgusted with the cruelty that had been perpetrated by his sanction and authority, resolved to take advantage of the troubles existing in France to make a conquest of that country. Thither he led a very large army, with which he defeated and almost wholly destroyed one six times larger than his own: he immediately advanced into the heart of the country, making himself master of many towns. At length he married Catherine, daughter of the French king, and acquired thereby the administration of affairs in that kingdom, during the life of his father-in-law, fully expecting to be appointed his successor. But his death, in the year 1422, frustrated his own and the nation's hopes. His son, an infant, was afterwards declared king of France and England; but, possessing none of his father's heroism, he soon lost in France all that Henry V. had acquired. The triumphs in France produced scarcely any advantages at home. As the English grew more warlike, they became more brutal; and in their eagerness after foreign possessions, they neglected the cultivation and improvement of those at home. The language became more barbarous. Chaucer and others, about a century before, seemed to have drawn it from obscurity, and enriched it with new terms and combinations; but at this period it relapsed into its former grossness.

The reign of Henry VI. witnessed much bloodshed, owing to the rival families of York and Lancaster. These calamities did not subside till the reign of Henry VII., who was himself of the house of Lancaster, and married the daughter of Edward IV. of the house of York, when an end was put to the dissensions between the different factions of the white and red rose. In the famous battle that fixed Edward IV. on the throne of England, it is said that 40,000 men were left dead in the field. In this dreadful contest, each party, as it happened to be victorious, called in the executioner to complete the bloody tragedy begun in the field. In the reign of Henry VI. the art of printing was first practised in England by William Caxton. He translated some French works, which he printed; and, by

his new art, gave currency and celebrity to the translations of others. The priests at this period possessed no small share of erudition, as is evident from some Latin productions still extant; but learning was separated from the purposes of common life, and though not neglected by the clergy, yet it descended no lower, the people at large not considering it as any concern of theirs.

The wars in which Edward IV. engaged were long and bloody; and, upon a suspension of arms at home, he proclaimed war with France, which he knew would gratify his subjects, who have been, at almost every period of their history, more fond of splendid than useful acquisitions. To prosecute this scheme, he sent to his ally, the duke of Burgundy, a reinforcement of 8000 men; and soon after followed himself, at the head of a very numerous army. The French king was alarmed at this formidable invasion, and feeling that he was unable to contend with his antagonist, he had recourse to treaty; and for a stipulated sum, Edward agreed to lead back his forces to England. Towards the close of life he indulged the hope of invading France again: his parliament consented, and in that assembly of the nation the project was unanimously declared to be just and necessary. The people seemed pleased with the prospect, and great preparations were made for the expedition, when, fortunately for the interests of humanity, Edward died after a reign of little more than 22 years.

Edward V. succeeded, as we have seen, (see EDWARD,) to the kingdom in name, but not in fact: for, long before he was capable of acting for himself, he was deposed and murdered at the instigation of his uncle, the duke of Gloucester, who secured to himself the crown under the title of Richard III. The infamy of this prince's character has been fully described by every historian of authority. As he obtained the government by treachery and murder, so he lost his life in support of what he had unlawfully gained. At the battle of Bosworth Richard had to contend with Henry, earl of Richmond, who was not only completely victorious, but was proclaimed king by the unanimous voice of the army, on the very spot in which the cruel Richard was slain. By the death of this king, the Plantagenet race, which had been in possession of the throne more than 300 years, became extinct. With him also terminated the contests between the houses of York and Lancaster, in which, in the course of about 30 years, an hundred thousand lives were lost either in battle or by the hands of the executioner. These dissensions had reduced the kingdom to a state of almost savage barbarity: laws, arts, and commerce were entirely neglected; every thing laudable gave place to the practice of arms. The people had attained no ideas of pacific government, nor could they applaud or justify those who cultivated it. In their wars, it is recorded to their credit, that the women, however formidable and active, were exempted from capital punishment, unless accused of the undefined and undefinable crime of witchcraft. The clergy were distinct from the laity in customs, constitutions, and learning: they were governed by the common law, which was delivered to them by the traditions of their ancestors. As a body, they did not interest themselves in the civil polity; and were not displeased to see the laity, whom they did not deign to regard as fellow-subjects, but rivals for power, weakening themselves by continual contests: the laity, on the other hand, regarded the clergy with blind veneration, which lessened their respect and attachment to the monarch on the throne. There was little virtue among individuals of the nation, and the government was subject to disorders of the most fatal kind, which perpetually produced all the horrors of civil war.

With

## ENGLAND.

With the reign of Henry VII. we commence a new era in the history of our country. Under his sway we behold one of the greatest revolutions that was ever effected by the prudence and perseverance of one great prince: a nation of tumult reduced to civil subordination; a haughty aristocracy humbled; wise laws enacted; commerce restored; and the arts of peace cultivated and encouraged by a people, to whom before, war, only was delightful. The whole government put on a new form, and Henry was one of the most useful monarchs that ever held the sceptre of these kingdoms. —

The first care of Henry was to unite the interests of the houses of Lancaster and York, by marrying Elizabeth, the daughter of Edward IV. His reign began very auspiciously by a strict obedience to the laws, which he ever after enforced with firmness and dignity. Before his reign it had been usual to take away the lives of those attainted of treason; but Henry thought it sufficient, in most cases, to deprive those taken in arms of their fortune and estates, which he applied to his own use. By these means he deprived his enemies of the power of injuring him; and he was enabled, by new accessions of wealth, to perform many acts of liberality. He is said to have released all prisoners for debt in his dominions, whose debts did not amount to forty shillings, and paid the creditors their whole demand from his own coffers. He has been accused of avarice, but it is doubtful whether his conduct in this respect does not rather merit the applause of useful economy. His government was disturbed by attempts at setting on the throne Lambert Simnel, as earl of Warwick; and afterwards by a similar attempt with regard to Perkin Warbeck. In the year 1499 he freed himself from these conspiracies, by the conviction and execution of Perkin and the feigned earl of Warwick. After this, the reign of Henry was truly respectable: his government was formidable to his own subjects, and claimed the respect of rival potentates. He paid much attention to the wants of the lower classes, and was anxious to depress in the scale of power the nobility and clergy. From these most of the calamities of former reigns had resulted; and on that account he contrived means to lessen their authority in the state. He allowed the nobility, by a law passed in his reign, to alienate their estates; and he diminished, as far as he was able, the privileges claimed by the clergy as their right. He was, at the same time, a friend to the people, who in former periods were the sure victims of powerful ambition and revenge. They, in all cases, were the sufferers, on whatever side they fought, if they had the misfortune to lose the victory. To remedy this, in a great degree, Henry procured the passing of an act, by which it was established that no person should be impeached or attainted for assisting the king for the time being. This wise statute served to repress the desire of civil war, as multitudes would naturally take arms in defence of that side on which they were sure of losing nothing by defeat, and their numbers would intimidate insurgents. But the greatest efforts of this king were directed to promote trade and commerce, which naturally introduced a spirit of liberty among the people, and disengaged them from their dependence on the nobility. Before this era, the towns owed their original to some strong castle in the neighbourhood, where the great lord generally resided, maintaining at his expence a very large retinue, who, as dependents on his bounty, were on all occasions bound to vindicate his cause. The number of these drew together, in or near the same place, artificers, victuallers, and shop-keepers, to furnish the lord and his attendants with the necessaries of which they stood in need. It was the wise policy of Henry to

bring the towns from such a neighbourhood, by inviting the inhabitants to a more commercial situation. He attempted to teach them frugality and the payment of debts; the life of industry, by his own example; and never omitted to include the rights and principles of commerce, in all his treaties with foreign princes.

At this period the continent, as well as the British isles, seemed to be making great advances to improvement. The sovereigns of Sweden, France, and Spain, were the encouragers and protectors of the rising arts. The Portuguese had sailed round the Cape of Good Hope, and Columbus had just made the discovery of a new world. Henry was desirous of following the example set him, and granted to certain enterprising merchants to go in quest of new countries. By these and similar exertions the king saw his country civilized, the people pay their taxes without insurrection; the nobility learning a just subordination, the laws alone suffered to inflict punishment, towns begun to separate from the castles of the nobility; commerce every day increased, and the spirit of faction was in a great measure extinguished. He was at peace with all the world, and having issued a general pardon to his own subjects, he had reason to expect the happiness to which wise measures and true patriotism are justly entitled; when, at the age of 52, he died of the gout in his stomach. In some respects he has been regarded as the second Alfred, a title to which he has a good claim, on account of the great changes which he introduced in his kingdom;—changes which had the most favourable tendency to effect the improvement and happiness of his subjects.

Henry VIII., the son to the late king, assumed the reins of power under the most fortunate auspices. He found himself in possession of a peaceable and flourishing kingdom; prudent ministers, who knew the wants of the people, and were ready to provide for them; and a well-stored treasury. The young king, however, made but an ill use of the bounties of providence, with which he was so abundantly surrounded. He had been diligently instructed in all the learning of the times; but his stock of knowledge served only to inflame his pride, and not to control his vicious affections. The love of his subjects was testified by an adulation, which produced the most mischievous effects. His vast wealth, instead of relieving his subjects, or of increasing the national honour, only contributed to supply his debaucheries, or gratify the rapacity of the ministers of his pleasure. The acts of his life will come more properly under the article devoted to his name. In this place it will be sufficient to observe, that he was perpetually falling from one extreme to another, and agitated by contrary passions; it became doubtful to his subjects in what manner they should act, or what they should believe, so as to obtain his approbation. His conduct as a king was marked with the most atrocious acts of tyranny; he expected every one to submit to his will, however frequently that will was changed: yet his reign is memorable on account of the great revolution that was achieved in it by the celebrated Luther, for a full account of which we refer to the article LUTHER. At first the king wrote against the doctrines avowed by the former; and for his ability and learning, obtained from the pope the title of “Defender of the Faith,” a title which has been continued to his successors to the present time. He afterwards revolted from the Roman church, and required that his subjects should acknowledge him, and him only as head of the church of England. The parliament, entirely dependent on the king, sided with him in his views of separating from the church of Rome, and readily complied with his other measures to strengthen

the reformation. Henry, who was an artful politician, knowing that his parliament was devoted to his will, made use of the opportunity to render himself absolute. He accordingly opposed the parliament against the monks, and obtained their suppression. While parliament was busy in suppressing the religious houses, most of which were houses of infamy, the king was devising methods of destroying the power of the suppressors. This was the origin of the unlimited power which he now assumed: he had a most complying parliament, ready to sanction not only what he did, which in many instances were deeds of the darkest hue, but likewise what he intended to do. He was not wanting to strengthen his own power, and claimed the same obedience to his proclamation as to the acts of the whole legislature. No king of England, as will be seen hereafter, lived so much the terror of his people. Some persons wielding a sceptre have been tyrants, from the frequent revolt of their subjects; some, from being misled by favourites; and some, from a spirit of party: but Henry VIII. was cruel, from a disposition which seemed prone to inflict misery on all about him; he was a savage in government, in religion, and in his own family: yet such are the inscrutable dispensations of heaven, that while the harmless Henry VI. was dethroned, imprisoned, and assassinated, the present tyrant was permitted to die a peaceable and natural death, if we except the sufferings which a guilty conscience cannot fail to inflict. Fortunately perhaps for the people, Henry contrived to dissipate all those treasures of which his tyranny plundered his subjects: he died poor, and transmitted the crown to his son and successor as dependent on the people for their supplies in parliament as at any former period. The wanton profusion of princes is always hurtful to themselves; but in many instances it has been beneficial to their subjects, by preventing greater evils. If Henry VIII. had been more frugal, he would probably have been more dangerous.

The character of Edward VI. has, under his own name, been described. He died at too early an age to act for himself; but during his short reign, the principles of the reformation were encouraged; people were allowed to use or disuse the practice of confession, as they thought fit; images were taken from the churches, priests were allowed to marry, the mass was abolished, and a liturgy was drawn up, which, with very few alterations, has been continued to the present times. Such important changes could not be effected without danger: insurrections were excited in many parts of the kingdom, which were without much difficulty suppressed, though many were the victims of the unhappy contests.

The reign of queen Mary was marked with cruelty and bloodshed. She restored the Roman Catholic religion, and without hesitation burnt, or otherwise destroyed, all who fearlessly opposed her will, and the will of her infamous ministers, Bonner and Gardiner. The reign of this sovereign was fortunately short; yet, in somewhat less than four years, five eminent and conscientious prelates, twenty-one ministers, and more than eight hundred subjects of lower rank in life, were consigned to the flames for maintaining what they believed to be truth: besides these, we have no accurate account of the numbers who died in prison, by more lingering and more cruel deaths than even the flames of Smithfield could inflict; nor has it been recorded how many, through fear of death, sacrificed a good conscience, and thereby endured for the remainder of their lives sufferings a thousand times worse than the death which a tyrant is enabled to order.

Elizabeth, whose character and government have been delineated in the last volume, restored the principles of the

reformation, and advanced the kingdom to the highest pitch of splendour. She had been nurtured in the school of adversity, and drew from it lessons of the highest importance to her future conduct. While secluded from the busy world in a lonesome prison, she was employed in the improvement of her mind; and in devising methods of reforming the church, so soon as providence should make way for her government; and one of her earliest acts as sovereign was to establish the reformed religion. The people readily seconded her designs: they perceived the ill use which the papists had made of their power in the last reign; and they were willing to suppose that the savage acts, which had been committed by Mary and her bishops, were the necessary consequences of the faith which they espoused, and in behalf of which they effected their cruel purposes. Elizabeth soon assembled her parliament, the reformation was finished, and that form of religion was established which is now deemed the religion of the country. The clergy, in general, subscribed to the new forms: of nearly ten thousand who were in possession of benefices of different degrees of rank and value, scarcely more than an hundred chose to quit the emoluments of their office, rather than abandon the principles to which they had adhered in the last reign. "Thus," says an historian, "England changed its belief four times since the accession of Henry VIII." Strange that a people, who are so resolute, should be guilty of so much inconsistency! that the same people, who this day publicly burn heretics, should the next not only think them guiltless, but conform to their opinions. Elizabeth, though firmly fixed on her throne, had enemies in almost all the neighbouring potentates; who endeavoured by every means in their power to excite discontent among her own Catholic subjects. In this situation, she could only rely upon the resources which proceeded from the affection of her subjects, and the wisdom of her administration. Her governing maxim was unquestionably founded in wisdom; it consisted in acquiring the esteem and affection of her people. She was an economist of the nation's money, and sparing in her rewards to her favourites. She distributed rewards and punishments with impartiality; knew when to flatter and when to upbraid; could dissemble submission and preserve her prerogatives; she studied the people she was to govern, and not unfrequently flattered their follies in order to secure their hearts.

The errors of this sovereign, and the acts of cruelty to which she gave her sanction, have been described in her own life, or in that of archbishop Cranmer, or will be found hereafter in the article Mary queen of Scots, or in other parts of this work of minor consideration; but it must be observed here, that whatever punishments or cruelties were exercised in this reign, they mostly fell upon the great, and in no instance were the people more happy internally, or more formidable abroad, than during this period. It will, however, be readily admitted, that it was not owing entirely to the queen that the nation was so completely prosperous at this period; the people, as if spontaneously, began to exert their native powers, and every art, and every genius put forth all their vigour. The English could not boast of new or splendid acquisitions: their influence in foreign courts was extremely limited, but commerce grew up and flourished. The people began to feel the effects of their own exertions, and to understand in what consisted the independency of a great nation; and England became at once laborious, enterprising, powerful, and in a degree polished and polite. The successful voyages of the Spaniards and Portuguese excited their emulation: they fitted out several expeditions with a view of discovering a northern passage to China, and, though

## ENGLAND.

though disappointed in their first and principal object, their voyages were not wholly fruitless. Our countrymen, Cavendish and sir Francis Drake, circumnavigated the globe, and discovered in the prosecution of their voyages a skill and prowess very superior to the most experienced navigators of those nations who led the way in nautical discovery. Sir Walter Raleigh, without any assistance from government, colonized New England; and these expeditions at length formed one of the most powerful marines of Europe, which in a very short time was enabled to oppose the fleet of Spain. (See ARMADA.) The superiority obtained by the English at sea, at this period, gave them a sort of naval sovereignty which they have ever since inviolably preserved, and which, we trust, they will very long maintain, notwithstanding the boastful language of the present emperor of France. If, for wise purposes, he must subject the continent to his power and controul, we trust that our own islands will, by union among the people, be freed from the tyranny which he has for many years been exercising among other nations, which have evidently been sacrificed by their own want of unanimity, and by the mismanagement of their sovereigns.

In the reign of Elizabeth, external commerce was not more cultivated than internal manufactures. Flemish manufacturers, who had been persecuted at home, fled to England for an asylum, which they found, and for which they made ample amends by the arts which they introduced, and the industry which was excited by their example, and by the wealth which their labours acquired. In polite arts and in literature the English excelled all other nations. The reign of Elizabeth has by some writers been denominated the Augustan age of literature. The disputes caused by the reformation of religion had retarded the progress of our language among the powerful, but they excited a spirit of enquiry among the middling and lower orders of society. The people began to read, and being allowed to peruse the bible in their own language, their morals, and perhaps their taste, rapidly improved. The reformers, who had fled from the persecutions of Mary, returned to promulgate their doctrines at home, and by a residence abroad their language was corrupted by foreign idioms and barbarous phrases. These archbishop Parker set himself assiduously to reform, as well by his own excellent example as by precept. He corrected the English translation of the bible, and printed it with royal magnificence. His own style possessed all the eloquence of the times; it was manly and concise, but wanted smoothness.

Such were the leading improvements in Elizabeth's reign; and, says a good writer, "if we look through history and consider the rise of kingdoms, we shall not find, in all its volumes, such an instance of a nation becoming wise, powerful, and happy in so short a time. The source of our felicity may be traced to the reign of Henry VII., and though the stream was interrupted by intervening tyrannies, yet, before the end of Elizabeth's life, who was his grand-daughter, the people became the most polished and the most happy people upon earth. Liberty, it is true, as yet continued to fluctuate: Elizabeth knew her own power, and often stretched it to the very limits of despotism; but when commerce was introduced, liberty necessarily entered in its train; for there never was a nation completely commercial, and at the same time perfectly despotic."

On the death of Elizabeth James VI. of Scotland succeeded to the throne of England, with the universal approbation of all orders of the state. Elizabeth bequeathed him her crown almost with her last breath; he was the nearest in the order of succession, and he had all the sanction which parliament could confer. He began his reign by a laudable

attempt to unite both kingdoms into one, which he effected without much difficulty, and from that period the two kingdoms have been governed by one sovereign. James, though used to arbitrary power, set himself to study the English laws, by the authority of which he resolved to govern. Whether he did not comprehend their full import, or that his habits were too much fixed to submit to the necessary changes which his new situation required, it would be useless to enquire; but it is certain that his whole reign was marked with disputes between him and his parliament. The king was ever attempting to keep the royal splendour unfulfilled; the other aiming at lessening the dangerous part of the prerogative: the one labouring to preserve the laws and institutions of former reigns; the other as steadfast in asserting the inherent privileges of mankind. When the parliament refused a subsidy, the king was desirous of availing himself of the precedents set by other monarchs, by extorting a benevolence. The house of commons felt their consequence as the protectors of the people, and remonstrated against every act of arbitrary power, as incompatible with their rights and privileges. These attempts of the crown, and the resistance of the people, continued through the whole reign, and first gave rise to that spirit of party which has ever subsisted in England, the one side declaring for the king's prerogative, the other for the rights and liberties of the subject.

James exhibited much moderation with regard to those who did not think on religious subjects as he was accustomed to think, and who did not conform to the established forms of church discipline, wisely judging that men should be punished for evil actions, and not for erroneous opinions. The conspirators against his government, as will be seen in his life, were severely punished; but he cultivated the arts of peace, and obtained as a just reward the general good will of the nation. It has been ascribed to this monarch that the English have attained to a noble freedom of thought, and the dignity of justifying their opinions. James neither cultivated nor understood foreign negotiations or alliances. His reign was marked with none of the splendours of triumph, nor with new conquests and acquired dominions; but the arts were silently advancing in improvement: reason was extending her influence, and desecrating a thousand errors in religion and government that had been rivetted by long prescription. The people began to think for themselves, to estimate their rights and consequence: the reformation had introduced a spirit of liberty, even at the time that the constitution and the laws were built upon arbitrary power. "James," says the historian, "taught them, by his own example, to argue upon these topics: he vindicated the divine right of kings against the natural privileges of the people: the subject began in the controversy, and it was soon discovered that the monarch's was the weakest side of the question."

Charles I. ascended the throne in the year 1625, and was extremely popular, as well on account of his own virtues and address, as in respect to the fortunate circumstances in which he was placed. The country was in a peaceable and flourishing state: his title to the crown was undisputed, and he had formed an alliance with one of the most powerful monarchs that ever reigned in France, whose sister he had married. The pleasing prospect was of short continuance; the people had learned to reason: they felt their own power, and it was determined in parliament to oppose the ancient claims of the crown. Charles had been taught to consider the royal privileges as sacred pledges, which it was his duty to defend: his father had implanted the doctrines of hereditary and indefeasible right early in his mind. James contemplated these

these doctrines in theory, but it was soon the fate of Charles to assert and defend them by action. He mistook the genius of the people he had to govern; they had imbibed the principles of liberty; but he wished to act by maxims and precedents that had their origin in times of ignorance and slavery. The late king had been forced into breach with Spain, and Charles gave early indications of a despotic temper, which rendered the parliament remiss in furnishing him with money for carrying on the war. In a short time his favourite Buckingham persuaded him to take the part of the French Hugonots, in their quarrel with the crown. They were ill supported, and the protestant interest received an irrecoverable blow in France. The blame was attributed by the people and parliament to Buckingham, who was assassinated by Felton. This the king laid seriously to heart, though it did not deter him from his arbitrary proceedings. For several years Charles reigned without assembling a parliament, during which he did as he pleased, promulgating laws, and imposing taxes on his subjects to the great mortification of those who felt for their liberties as men and Englishmen. He laid arbitrary impositions upon trade, which many resisted: he levied monies upon monopolies of salt, soap, and other necessaries of life. His government became every day more unpopular, and Burton and Pryne wrote against the proceedings of the court. They were prosecuted for their writings in the star-chamber in a very arbitrary and cruel manner, and punished with so much severity as excited an almost universal indignation against the authors of their sufferings. The king next made use of Laud and Strafford as instruments in carrying on his despotic measures. These he was in a short time obliged to abandon to an ignominious death on the scaffold. Charles, in the early part of his reign, had passed the petition of rights into a law, which was intended by parliament for the future security of the liberty of the subject, by which it was enacted "that no man hereafter should be compelled to make any gift, loan, benevolence, tax, &c. without common consent of parliament." This principle he perpetually violated till at length a civil war broke out. Notwithstanding the many acts of tyranny and oppression, of which the king and his ministers had been guilty, yet multitudes sided with the court and joined the standard of Charles. Many of the nobility and gentry were attached to the crown, and considered their own honours as connected with it, and no inconsiderable part of the landed interest joined the king. The parliament claimed for themselves the executive power, and were favoured by most of the trading towns and corporations; but its great resource lay in London. The first battle was fought at Edge-hill, in Warwickshire, in which the royalists were so far triumphant that parliament was obliged to invite the assistance of the Scots, who entered England with 20,000 horse and foot. From this period war was carried on with various success, till at length the king was overpowered, reduced, imprisoned, tried, and finally beheaded. The character of this prince will be found under the article CHARLES I. With the death of the king, the miseries of civil war terminated, and the parliament, which was triumphant, had now no enemy to fear, except those very troops which hitherto had been instruments in their hands, in achieving their designs. At first they hoped to disband the troops; but Cromwell, who was the rival power in the state, had other projects to accomplish. He had already rendered the army in a great measure independent of the parliament; and now formed a council of officers, and another of common soldiers, called agitators, who were appointed to enquire into the grievances of the military, and lay them before parliament. As the commons, from neces-

sity, granted their requests, the army rose in their demand, till at length the parliament enjoyed but the shadow of authority. It, however, passed an act, making it high treason to acknowledge Charles Stewart, son of the deceased king, as successor to the throne. They likewise voted the house of lords useless and dangerous, and passed an act for the abolition of all kingly power. A great seal was made, on one side of which were engraved the arms of England and Ireland, and on the reverse was represented the house of commons sitting, with the motto, "The first year of freedom, by God's blessing restored 1648." No measure was omitted that could probably establish the power of the usurper, and exclude for ever the kingly power in England. Much was done for retrieving the glory of England at sea. Cromwell and Ireton excited the jealousy of the republicans, who contrived first to employ them in the reduction of Ireland, and afterwards against the Scots, who had acknowledged and received Charles II. as their king. Almost immediately, by the most unparalleled exertions, a fleet was produced superior to any that had ever been seen in Europe. An act of navigation was passed, and war was declared against the Dutch, who were till then regarded as invincible at sea. Cromwell, from his successes in Scotland, found little difficulty in obtaining the honour of being declared commander in chief of the English army. Admiral Blake, and other naval commanders, carried the terror of the English name by sea to all quarters of the globe, and Cromwell, having little employment, began to think how he might establish his own authority paramount to that of the state. On the 20th of April 1653, at the head of 300 musqueteers, he dissolved the parliament, opprobriously driving the members, about one hundred in number, out of their house. He next annihilated the council of state, with which the executive power was lodged, and transferred the administration of government to about 140 persons, whom he summoned to Whitehall on the 4th of July 1653. After this he was declared lord protector; which, however, did not comport with his ambitious views; he was desirous of the name; as well as the power of king, to which he could never arrive; and in September 1658, he died after an usurpation of nearly five years. See CROMWELL.

From Charles's death in 1648, to the decease of Cromwell in 1658, England was unquestionably improved equally in riches and power; besides the introduction of the navigation act, which was established in the reign of Charles II. and which has been regarded as the palladium of English trade; monopolies of all kinds were abolished, and liberty of conscience to all sects was granted, which was highly advantageous to the population and manufactures of the country. Under Cromwell, the arts, sciences, and literature were not much encouraged, yet he did many things worthy of praise; and as his genius and capacity led him to the choice of fit persons for the several parts of administration, so he paid some regard to men of learning, and particularly to those entrusted with the care of youth at the universities. Richard, his successor, possessed none of the talents for business, nor indeed any activity of disposition, for which his late brother was so celebrated, and was in a very short time driven, without resistance, into that obscurity for which his temper was better adapted, than for the business of government. The resignation of his power made way for

Charles II. who returned to the throne of his father by the general concurrence of the people; this was in the year 1660, and for some time he seemed desirous of promoting the people's happiness, though he did not forget to avenge himself on the enemies of the late king; the bodies of Cromwell, Ireton, and Bradshaw were taken from the tomb,

and treated with every indignity. Of those who sat in judgment on Charles I. some were dead, others had left the country, and some the reigning prince thought deserving of mercy, but ten were devoted to almost immediate destruction. These bore their sufferings with the constancy of martyrs dying in a good cause, thanking heaven in the extreme of their torments, that they were allowed to be witnesses of the truth. It was now to be feared that the tide of loyalty would bear away in its course all the former moulds of freedom. Parliament seemed to concur in all the designs of the court, and even to anticipate its wishes; but the monarch was by no means attentive to those who had followed him in his misfortunes; his pleasures and his flatteries engrossed all his cares, and exhausted his finances, so that he had nothing left, and, apparently, no wish to pay the debt of gratitude. From those who would willingly have expostulated with him on his misconduct, he fled, and endeavoured to forget every kind of serious business in scenes of mirth, riot, and debauchery. By his own example, he undermined the principles of religion, and the nation, prone to extremes, exhibited every species of licentiousness, which was practised in the most dissolute court that ever existed in England. Charles II. though without a pretence to religion, permitted the persecution of sectaries, which excited among those, who were objects of it, a plan for a general insurrection. The plot was discovered, and the conspirators were taken and executed. This circumstance afforded a pretext for continuing the parliament then sitting; and repealing the act for triennial parliaments, as being dangerous in times of commotion. This parliament was so completely subservient to the will of the king, that he might, with activity, have become absolute. They confirmed the infamous doctrine of passive obedience by a solemn act, and assigned the king a revenue of twelve hundred thousand pounds, a sum which none of his predecessors had ever possessed; nevertheless his prodigality rendered him indigent, and instead of desiring an ascendancy over his parliament, he was content to be a perpetual dependent on their bounty. His prodigality and libertinism soon alienated the affections of his subjects, which in the short period of two years were changed to a contempt of his person and administration. The war, in which he engaged with the Dutch, was unattended with any brilliant success, and the enemy's attempting to sail up the river Thames excited clamours against the government. The people began to compare the present state of things with the measures and administration of Cromwell; in the one case they enjoyed security at home, and claimed the highest respect from surrounding nations; in the other every principle, private and public, was forced to give way to the passions of the sovereign, which he was determined to gratify at any expence. Uniformity in religion became the popular cry, and, in 1673, the test act was passed, obliging every person in or under government, not only to take the oaths of allegiance and supremacy, but receive the sacrament of the Lord's-supper in some parish church, before competent witnesses, and subscribe a declaration renouncing the doctrine of transubstantiation. This was levelled against the duke of York, the king's brother, who was an avowed papist, and whom the parliament wished to exclude from the throne. The fears and discontents of the nation were vented without restraint, which gave great offence to the court. A great degree of severity was exercised against the nonconformists to episcopacy, and every means taken that was likely to repress the rising spirit of the country. It was known or violently suspected that Charles was a pensioner on the court of France, his parliament in 1677, addressed him to make war upon that country, which

he refused. The people became exasperated against almost all public measures; the king was alarmed with the prospect of a civil war, and made considerable concessions to avoid the odium which his past conduct had justly incurred. Many of the leading members of parliament had however determined on such a change as should exclude the duke of York from the crown. To forward this the famous plot of Titus Oates was contrived, which charged the papists with a design of murdering the king, and of introducing popery by means of the Jesuits, as the established religion of the country. Several respectable persons were tried and convicted, principally on the evidence of Oates, who was unworthy of credit. A bill was brought into parliament to exclude the duke from the throne, which was passed in the commons, but was thrown out in the house of lords. A plot was now invented on the other side, in which the principal protestants were accused of an endeavour to destroy the king. For this, on the evidence of lord Howard, a man of infamous character, lord Russel, who had been zealous in his opposition to the popish succession, Algernon Sidney, and other distinguished characters, were tried and executed. The terror which the measure carried with it intimidated the best friends to their country; it silenced the opposition of the city of London and other corporations, and the duke of York triumphed in the victory which had been obtained by perjury. From this period the reign of Charles was as absolute as that of any monarch in Christendom, but the spirit of freedom, which the people had imbibed, struggled hard against the spirit of obedience, which the clergy attempted to inculcate. Another civil war threatened the nation still more dreadful than the former, as the forces were more equally divided; but fortunately for the peace of the country, the king was suddenly seized with an apoplectic fit, and died in the fifty-fourth year of his age.

Though England, during the reign of the second Charles, was agitated by contending interests, yet commerce continued to increase; its good effects had been duly appreciated, and multitudes were ready to turn their wealth and industry into this course. Many new manufactures were introduced, and many old ones brought to perfection. When France, by shameful and wicked policy, banished her best subjects, the protestants, England opened her arms to receive them, and with them she received large accessions of national wealth. To the afflictions and exile of this monarch we are indebted for many of our best vegetables which were introduced by his followers from the continent. Science and literature made rapid progress during this reign: Newton and Tillotson; Burnet and Shaftsbury; Butler and Dryden flourished at this period: the Royal Society was instituted, and from this time our countrymen took the lead in every useful science, and they have maintained their superiority to the present hour. Nor must it be forgotten, that if Charles was the first of our monarchs who claimed the protection of standing forces, yet to him and his brother we are indebted for some very important improvements in the art of ship-building, an art which has given us a preponderating balance among the nations of the world, and which, we trust, will, in the hands of an over-ruling providence, preserve us from that overwhelming ruin in which almost all the empires of the continent are involved.

The opposition, which during the late reign had shaken the throne, vanished almost entirely at the accession of James II. The affection of the people seemed to know no bounds when the king, as it were, spontaneously made a declaration in favour of the church of England. That church, to flatter the prejudices of the present and late monarchs, had authoritatively from the pulpit and press pronounced all resistance to a

reigning sovereign unlawful: a doctrine which, however pleasing it might be to the feelings of the king, proved fatal to his peace, and, in the event, drove him from the kingdom. The army and people supported him in crushing an ill-concerted rebellion of the duke of Monmouth, who pretended to be the lawful son and heir of Charles II., and had assumed the title of king. The duke was taken and was beheaded; and some hundreds of his adherents lost their lives likewise by the instrumentality of judge Jeffries and colonel Kirke, names that have been deservedly handed down to posterity with every infamy that can attach to human nature. James, with such assistance, determined to try how far the church of England would agree in the practical assertion of the doctrine of non-resistance. He was set upon introducing popery as the established religion of the country. He laid pretensions to a power of dispensing with the known laws; he instituted an illegal ecclesiastical court, and openly received and admitted into his privy council the pope's emissaries, and gave them more respect than was due to the ministers of a sovereign prince. He sent an embassy to Rome, and received, at his court, the pope's nuncio, and, to crown all, his encroachments upon the civil and religious liberties of his people were carried beyond all bounds, even to the disgust of Roman catholics themselves; and the pope was too good a politician not to know that the course taken by James must eventually ruin the cause which he professed to advocate. The church of England took the alarm, when the king had ordered a declaration to be read, by which every restraint on popery was removed. Seven bishops refused to comply with their sovereign's order, and presented a petition to excuse their refusal. They were cited before the council to answer for their conduct, and adhering to their resolution, were committed to the Tower, prosecuted by the attorney-general for sedition, tried, and gloriously acquitted. The joy of the people, on this occasion, was inexpressible: the city and the country seemed at once to catch the shouts of exultation. James heard the intelligence with fullen silence, and evident indignation, while he was at dinner in his camp. From the church he turned to his army, who proved equally hostile to his views. Opposition, however, served only to increase his zeal, till at length some of the principal people in the country resolved to apply for relief to William, prince of Orange, who was at once the nephew and son-in-law of James II. William, who was an able politician, and ambitious of wearing the crown of England, readily listened to the proposals made him, embarked in their cause, and landed a large army almost before his designs were suspected by the court of James, who, in a few days deserted their old master, and sought protection from the new. The old king was now deeply convinced of his errors, and would gladly have retracted his measures, but it was too late: he found himself abandoned by his army and fleet, and learnt, with apparent consternation and horror, that the prince of Denmark and his favourite daughter Anne had gone over to the prince of Orange. On this intelligence he is said to have wept bitterly, exclaiming, "God help me, my own children have forsaken me." He now hung over the precipice of destruction, invaded by one son-in-law, abandoned by another, hated by his subjects, and held in utter detestation by the friends and relations of those who had suffered by his cruelty. He assembled the few noblemen who still adhered to his cause, and demanded their advice and assistance. Addressing himself to the earl of Bedford, father to lord Russel, who had been beheaded at the instigation of James in the preceding reign, "My lord," said the dejected monarch, "you are an honest man, have great credit, and can do

me signal service." "Alas! sir," replied the earl, "I am old, and very feeble, and can afford you but little service, but *I once had* a son that could have assisted you in this extremity, but he is no more." James was so struck with the reply, that he could not speak for many minutes. After this he almost instantly resolved to abandon his country, and seek for himself, his queen, and his son, real or pretended, then only six months old, an asylum in France, where he passed the remainder of his life among a people who pitied, ridiculed, and despised him.

From this moment the constitution of England, which had fluctuated for ages, was fixed. The nation, represented by its parliament, determined the long contested limits between the king and the people: they prescribed to the prince of Orange the terms by which he was to rule, and appointed him king jointly with Mary, who was the next protestant heir to the crown. They were shortly after crowned by the titles of William III. and Mary, king and queen of England. The prince had his ambition amply gratified, and his wisdom was repaid with that crown which the folly of his predecessor had thrown away.

The power of William was limited on every side, and he met with an opposition from parliament which he did not expect. His chief object was to humble the power of France, and he fully anticipated the utmost efforts of the English to second his views, but he found them more intent upon guarding their domestic liberties than eager against continental powers; notwithstanding this, his reign was spent in an almost uninterrupted course of hostilities with France, at an expence she had never known before. The nation had grown cautious through the experience of the two last reigns, and he gave his consent to the "bill of rights," by which the liberties of the people were confirmed and secured, though not in so ample a manner as might have been done at a crisis when a crown was bestowed by the free voice of the people. The last two kings had made a very bad use of the whole national revenue, of which they had an unlimited use, and it was found in their hands quite sufficient to raise and maintain a standing army. The revenue was now divided, part of it was allotted for the national service of the year, and was to be accounted for to parliament; and part, which has ever since been denominated the civil list money, was given to the king for the support of his house and dignity.

William was averse from persecution, and began his reign by attempting a repeal of those laws that enjoined uniformity of worship, and though he could not do all he wished, yet he obtained practical toleration for the dissenters; and the laws against the papists were rarely executed. He was, however, a stickler for what he regarded as the privileges of the crown, and often controverted, and remonstrated against the views of his parliament, and was, not unfrequently, arbitrary in his councils. He opposed with the utmost vehemence the bill for triennial parliaments, and, when it had actually passed the two houses, he refused to give it his royal assent. The house of commons, who are or ought to be the representatives of every individual in the country, took fire at this abuse of the royal prerogative, and voted, with becoming spirit, "that whoever advised the king to this measure was an enemy to his country," and no king has since ventured upon so outrageous a proceeding. The bill, thus rejected, lay dormant till the next sessions, when William found himself obliged to comply. The same opposition and the same success attended a bill for regulating trials in cases of high treason, by which the accused was allowed a copy of his indictment, and a list of the names of his jury, two days before his trial, together with counsel to plead in his defence, and that no person should be indicted

but upon the oaths of two witnesses. It was by incessant struggles against the crown that the invaluable rights of the people have been transmitted to their posterity; and a just regard to these rights, civil and religious, was what led them to agree to the revolution. In other respects they had no reason to desire a change, nor can it with justice be imputed to the English that they affect important national revolutions. When James was dismissed, the wealth and prosperity of the nation were at their highest pitch, the tonnage of their shipping, both for merchandize and war, had been nearly doubled in the last 25 years: the increase of the customs, the surest test of increasing commerce, and the annual rental were nearly in the same proportion. Hence a strong party was formed against the king's ambitious and warlike pursuits, which were not always successful, and which drained the country of much wealth. The Irish were still desirous of a Stuart king, as were many of the English, though they spurned the idea of having even James forced upon them by the right of conquest. Parliament enabled the king to reduce Ireland, and to gain the famous battle of Boyne, (see *BOYNE*,) which crushed all the hopes of the exile king, and in 1692 the marine of France, which had hitherto vied with that of England, received an irrecoverable blow in the defeat at La Hogue.

Invasions were threatened, and conspiracies discovered every day against the government, and the supplies required to carry on a continental war obliged the parliament to open new resources for money. A land-tax was imposed, and every one's lands were taxed according to their valuations given in by the several counties. To this reign also we are indebted for the most important operation in finances that ever took place, which was the carrying on the war by borrowing money upon parliamentary securities, and which form what are called the public funds. The projector of this scheme, which has been acted upon, beyond the limits of human imagination, (see *DEBT, National*,) was Mr. Charles Montague, afterwards lord Halifax. The argument on which he depended to carry his plan into effect, was that it would oblige the moneyed part of the nation to become the zealous and steady friends of the revolution, because, after having lent their money to the nation, they could have no hopes of repayment or even of interest for it, but by supporting the existing government.

Notwithstanding the advantages which the nation derived from the administration of William, he was subject to so many mortifications from his parliament, that he seriously resolved to abdicate his throne, a resolution which he with difficulty abandoned, and certainly with the hope of being supported more effectually in the war with France, but he was in a great measure disappointed, and obliged to conclude the peace of Ryswick in the year 1697; and in the general pacification, the only equivalent obtained by the nation for an immense waste of blood and treasure, was the king of France's acknowledgment of king William's title to the crown.

One of the last and most important acts of this reign was the passing of a bill for settling the succession to the crown in the house of Hanover, which received the royal assent in June 1701. Shortly after this the king felt his constitution giving way, which he endeavoured to counteract by the exercise of riding, and in one of his excursions to Hampton court, his horse fell under him, and he himself was thrown off with such violence that his collar-bone was severely fractured, an accident which, in a few days, put an end to his life, in the 52d year of his age, and the eleventh of his reign. The character of this prince will be more particularly given under his own name. It may, however, be observed

in this place, that he was ill formed for acquiring popularity: his manners were cold and forbidding, and he sometimes seemed almost lost to those principles of liberty, for the support of which he had been raised to the throne. Nevertheless, the rescue and preservation of religion, and public liberty, were the chief glory of William's reign, for under his auspices England suffered grievously in her actions both by sea and land, and the public debt at the time of his death amounted to the sum of fourteen millions sterling.

The successor to William was Anne, the second daughter of king James by his first wife. She ascended the throne in the thirty-eighth year of her age, having suffered many severe mortifications during the reign of the late king, but upon her accession she followed his steps, and shortly after declared war against France, appointing the earl, afterwards the duke of Marlborough, to the command of her armies. Under this general many important victories were achieved. Those of Bleenheim and Ramillies gave the first effectual checks to the French power. By the former, in 1704, the emperor of Germany was saved from impending destruction, and 20,000 of the enemy were said to have been killed, wounded, or drowned in the Danube. About the same time sir George Rooke reduced the famous fortress of Gibraltar, which still remains in our possession a monument of the bravery and talents of the English admiral. The battle of Ramillies, fought in 1706, was of the utmost importance to the cause for which the war was undertaken; viz. to place Charles duke of Austria on the throne of Spain, for immediately after that victory, the states of Flanders assembled at Ghent, and recognized Charles for their sovereign. In Spain itself the English were unsuccessful; the burdens of the war falling chiefly on this country, the people, who are ever delighted at victory, began to murmur at the taxes imposed on them. Other circumstances led to disputes respecting the prerogative, the succession, and religion, which created great ferments in the nation and parliament. Negotiations for peace were carried on some time, but without success. At this period the leading parties in the nation were whigs and tories, at the head of the former was the duke of Marlborough, who supported by the queen was for a continuance of the war, in which her majesty concurred, till means were found to convince her, that it would finally prove ruinous to her and the people, and that the whigs were inimical to the national religion. The cry of "the church is in danger," at length displaced the whigs, and even drove the duke of Marlborough from the command of the army, an act which excited the astonishment of all Europe, for so numerous had been the victories acquired by his valour, and so high was his reputation, that his name was equivalent to an army. There is little doubt that whatever the faults of the whigs might have been, the honour and interests of the nation were sacrificed to court intrigues and private cabals. In the midst of all the disputes the whigs accomplished the union between the two kingdoms of England and Scotland, which has proved of great benefit to both, but which at the time excited the most violent clamours against the projectors. The English expected nothing from the union of so poor a nation, but a participation of their necessities: they contended it were unjust that while Scotland was granted an eighth part of the legislature, it yet should be taxed only a fortieth part of the supplies. The Scots, on the other hand, conceived that their independency would be wholly destroyed, and the dignity of the crown betrayed; they dreaded an increase of taxes, and were not very anxious for an increase of trade. After some ineffectual struggles the Union was effected: Scotland was no longer to have a parliament, but to send

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sixteen peers, chosen by their nobility, and forty-five commoners, to the English parliament, and from that period the two kingdoms were called by the common name of Great Britain, and all the subjects of both were to enjoy a communication of privileges and advantages.

In 1712 conferences for negotiation between England and France were opened, which led to peace. This was condemned by the whigs as injurious to the honour and interest of the nation. The majority of the house of lords inclined to that party, but that of the other house was tories. The queen, dreading that the lords might reject the terms of peace, by an unprecedented exercise of her authority, created twelve peers at one time, which secured the approbation of the parliament for the peace. The remainder of this reign was a scene of contention between the two parties. Each reviled the other in turn, and these commotions served still more to impair the queen's health, till at length she felt herself unequal to the duties of her station. She sunk into a state of insensibility, and found a refuge from her anxiety and cares in lethargic slumber. Every precaution was taken to secure the succession in the house of Hanover, and orders were sent to the heralds at arms to be in readiness to proclaim the elector of Brunswick king of Great Britain. The day before the queen died she seemed to revive, rose from her bed, and walked about, when, casting her eyes on the clock that stood in her chamber, she continued to gaze for some time, and being asked what she saw more than usual, she replied only with an expressive but dying look, and about seven o'clock the next morning, Aug. 1, 1714, she expired in the thirteenth year of her reign. The national debt had, during this reign, increased from fourteen to fifty millions. See ANNE, CHURCHILL, &c.

With this princess terminated the line of Stuarts, which, from the accession of James I. 1603, had swayed the sceptre of England one hundred and eleven years, and that of Scotland 343 years. On the death of queen Anne, there was still left the son or supposed son of James II. who had been acknowledged king by the court of France on the decease of his father in 1701. In behalf of this prince, rebellions were excited in England in 1715 and 1745. He resided at Rome, and kept up an appearance of a court till his death in 1765, leaving two sons, who are since dead and without issue.

By the act of succession George I. son of Ernest Augustus, first elector of Brunswick, and Sophia grand-daughter of James I. ascended the British throne; his mother, who would have been next in succession, having died a short time before. He arrived in England with strong prepossessions against the tory ministry, most of whom he displaced, without producing much effect in England, but in Scotland a rebellion was excited by some of the leading men of that country, who paid for their temerity the forfeit of their lives. Commotions and riots were raised in London, Oxford, and other parts, but these were happily suppressed, and the ringleaders in various instances were made examples of justice. The earl of Oxford, who had negotiated the peace of Utrecht, was charged with high treason on that account, but the prosecution was abandoned. The situation of affairs would not permit the ministry to venture upon a new parliament, and the members of that which now existed voted a continuance of their duration from three to seven years, one of the greatest and most indefensible stretches of parliamentary power ever known. Several other measures, hostile to liberty and the principles of the existing constitution, took place at the same time. Mr. Shippen, a member of parliament, was committed to the Tower for asserting in his place, that the king's speech was better cal-

culated for the meridian of Hanover than of London; and a young man, a printer, was actually hanged for a pamphlet, said to have been scarcely deserving of animadversion. George I. however sagacious, and in many respects moderate, was too much attached to his German dominions, and rendered England in a great measure subservient to them. He quarrelled with the czar of Muscovy about their German concerns, and had nearly involved this country in a war with Charles XII. of Sweden, for having as elector of Hanover purchased Bremen and Verden of the Danes. In 1718, he quarrelled with Spain on account of the quadruple alliance that had been formed between Great Britain, France, Germany, and the States General, and admiral sir George Byng, by his orders, destroyed the Spanish fleet. The war was quickly terminated by the Spaniards delivering up Sardinia and Sicily, the former to the duke of Savoy, and the latter to the emperor, and by the king of Spain consenting to sign the quadruple alliance, in which England was very little if at all interested. See ALLIANCE.

The next thing of importance was the securing the dependency of the Irish parliament upon that of Great Britain. The house of peers in England had reversed a decree made by the Irish house, which excited long, animated, and even bitter discussions, till at length a bill was brought into the English parliament, by which the Irish house of lords was deprived of all right of final jurisdiction, which, notwithstanding the most violent opposition from several leading members of both houses, was carried by a great majority. The ferment occasioned by these discussions was followed by the South Sea scheme, which promised immense wealth to those who engaged in it, but which left a large part of the nation in distress and ruin. (See BUBBLE.) Justice was demanded, by petitions from all parts, upon the contrivers of the scheme, and the nation seemed, as to a man, highly exasperated. During these transactions, the king, with serenity and wisdom, presided at the helm, influenced his parliament to pursue equitable measures, and, by his councils, endeavoured to restore the credit of the nation. The discontented availed themselves of public calamities, and made another attempt against the reigning sovereign. Their designs were soon detected, and Christopher Layer, a young gentleman of the Middle Temple, was convicted of treasonable acts, and suffered death on the account. Several noblemen and other persons of distinction were suspected of being in the plot, but of these the bishop of Rochester was the only victim who was banished the kingdom for life. After the ferment which this plot occasioned was over, the transactions of the reign were few and less important in their consequences. The ministry, who were all in the interest of Hanover, ventured upon several bold measures, in some of which the national interest, if not honour, was evidently sacrificed to that of the electorate. The crown of Great Britain was engaged in every continental dispute, however remote it was from her own interest. Treaties lately concluded with Spain were again broken, and admiral Hosier was sent to intercept the Spanish galleons from America, an expedition which proved as fatal as it was inglorious. The admiral and most of his men perished by epidemical diseases, and the hulks of his ships rotted so as to render them utterly unfit for service. To retaliate, the Spaniards undertook the siege of Gibraltar, and with similar success. New treaties were set on foot, France offered its mediation, and a reconciliation was effected. The king died, as he was travelling to his Hanoverian dominions, at Osnaburgh, on the 11th June 1727, in the thirteenth year of his reign. During his reign the sinking fund for diminishing the national debt was instituted. See DEBT National, FUNDS, &c.

Upon

Upon the death of George I. his son George II. ascended the throne, with a predilection for his Hanoverian dominions similar to that of the late king. He chose for his first minister sir Robert Walpole, who had filled the same high office under his father. This able minister was a decided enemy to war, which, in some instances, led him into difficulties both at home and abroad. His administration will be more properly considered under the article attached to his name, (see WALPOLE,) but justice requires of us to observe, that notwithstanding some of his measures, as an attempt at the introduction of the excise laws, were liable to great censure, yet he was friendly to the existing laws: he filled the courts with able and upright judges, and he has not been charged with any attempt at the violation of the known law of the kingdom, and under his administration the press was under little or no restraint. His pacific system more than repaid to the nation all that was required to support it, by the increase of her trade and the improvement of her manufactures. The great objects of controversy during the early part of this reign were the national debt, and a standing army. Demands for new supplies were made every session of parliament, either for the purpose of securing friends on the continent, or of guarding the internal polity, or for enabling the ministry to act vigorously in conjunction with their allies abroad. These were as regularly opposed as they were made: the speakers of the country party ever insisted, that the English had no business to embroil themselves with the affairs of the continent; that expences were incurred without prudence or necessity; and that the increase of the national debt by multiplying taxes, would in the end become intolerable to the people. A motion was made to revert to the old system of triennial parliaments, as they had been settled at the revolution. The advocates for this measure asserted that the septennial act was an encroachment on the rights of the people; that it was introductory to the monstrous corruptions of government: that during the continuance of that parliament which prolonged its existence from three to seven years several severe laws had been enacted; that by one of these a man might be removed, and tried at any place where the jury might be found favourable to the crown, and where a prisoner's witnesses could not and dared not come; that by another, a justice of peace was empowered to put the best subjects to death after reading the riot act. The ministry was, however, triumphant, and the opposition, who, unquestionably, had the weight of argument on their sides, complained that debate was useless, and that it was wholly impossible that reasoning could prevail over the corruptions that were secretly practised by the minister. Despairing, therefore, of being able to stem the torrent of corruption, they retired to their seats in the country, and left the ministry an undisputed majority in the house.

In November 1737, queen Caroline, consort to the king died; at this time the king and his son Frederick the prince of Wales were at variance. The latter complained that through Walpole's influence he was deprived not only of the power but the provision to which his birth was entitled. The king forbade him his presence, and gave orders that none of his friends should be admitted at court. A motion was made in the house of commons for increasing the prince's settlement, which was fifty thousand pounds; this was opposed by sir Robert Walpole, and rejected by a large majority. The prince now placed himself at the head of the opposition with so much firmness, that it was seen Walpole's power was drawing to a crisis; but it was not till the year 1742 that he resigned his employments and was created earl of Orford. The king bore the loss of his minister with the

greatest equanimity, and even conferred titles of honour, and posts of distinction upon the heads of opposition. Circumstances also arose which induced him to take a leading part in a continental war: in opposition to which a rebellion in behalf of the pretender was excited in 1745 in Scotland. Charles, the son of the pretender, landed in the Scottish islands, and soon found himself at the head of 1500 men. Manifestoes were widely dispersed, inviting the highlanders to join in the cause: few, however, seemed willing to hazard the dangers of the enterprize. Its boldness astonished Europe; it awakened the fears of the pusillanimous, the pity of the wise, and the loyalty of all. The whole kingdom seemed unanimously bent upon opposing the enterprize which they were sensible, as being supported only by papists, would be instrumental in restoring popery. The rebels advanced to Perth, where, instead of proceeding with increased rapidity, they staid to proclaim the prince's father king. The prince was again successful at Preston Pans, and marched to Edinburgh; here he wasted his time in dissipation and parade, till an opportunity was given to the king to send against him an effectual force under the duke of Cumberland. The battle of Culloden on the 15th of April 1746, put an end to all hopes of the pretender: the victory on behalf of the king was complete, but the merciless fury of the conquerors upon the fallen disgraced the cause, to which every friend of his country wished success. The duke ordered nearly forty deserters to instant execution, and the royal army spread terror wherever it came, and after a few days the whole country was one scene of slaughter, desolation, and plunder; justice was forgotten, and every virtue seemed to be lost in the most savage vengeance. The government on this occasion was not a little indebted for the support it received to the national debt. The Jacobite party had hoped to ruin public credit, but common danger abolished all distinctions, and united them in defence of private property. The merchants agreed to receive bank notes in payment, which prevented the mischief that was hoped for by a run upon the bank. The defeat of this rebellion in the year 1746 did not restore tranquillity to Europe; it was not till after various successes in different parts of the globe that the preliminaries of peace were signed in April 1748, and in the October following a definitive treaty was concluded at Aix-la-Chapelle. In the prosecution of this war the balance of gain, as far as wealth was concerned, was evidently in favour of Great Britain, and many private persons made it subservient to the attainment of vast fortunes. In the following year, the interest of the national debt was reduced from four to three and a half *per cent.* at which rate it was to continue for the next seven years, when it was to suffer a farther reduction to three *per cent.* This, says the historian, was the boldest stroke of financing that ever was attempted perhaps in any country, consistently with public faith, for the creditors of government, after a trifling ineffectual opposition, continued their money in the funds, and a few who at first sold out were glad, in a short time, to have it placed under the same security.

At this period Mr. Pelham was the minister of the country, who turned his attention to the improvement of commerce, manufactures, and fisheries, the benefits of which descended to posterity. A new treaty of commerce was signed at Madrid, between Great Britain and Spain, by which, in consideration of 100,000*l.* the South Sea Company gave up all their future claims to the Assiento contract, by virtue of which that company had supplied the Spanish West Indies with slaves from the coast of Africa. (See ASSIENTO.) In March 1750, his royal highness Frederic prince of Wales died, to the regret of the nation: and in the following year an

act was passed for regulating the commencement of the year, by which the old style was abolished, and the new style established, which was done by linking eleven days in 1752, and from that time the year was to begin the first of January instead of March. (See CALENDAR.) In 1753 the famous act was passed for preventing clandestine marriages, which at the time excited the most violent opposition, as replete with the most injurious consequences to the liberties and morality of the people, and as making an impassable line between the rich and the poor: and about the same time an act equally, or even more unpopular, as attacking the religious prejudices of the people, was passed. This was a law for naturalizing the Jews, which, though carried through great opposition, was in the next session repealed. The game laws were also introduced about this period; by these none but men possessed of certain property could have the privilege of carrying a gun, or of otherwise destroying game, though on grounds which they rented themselves. This measure was supposed to be a violent encroachment on the liberty of the subject; that it would necessarily damp the martial spirit of the lower orders of society, by preventing them from handling those arms which might one day be necessary to defend their country; and at the same time, that it gave the rich the sole enjoyment of a pleasure, which before had been considered as the common privilege of humanity. "Such," says a contemporary writer, "were the laws passed at this period, through all which a spirit of aristocracy was discerned by some. The body of the rich, no longer fearing oppression from the throne, or an infringement of their own liberties, now began to lean heavy on the poor, and to consider the interests of that useful part of the society as entirely distinct from their own. They never omitted, however, their usual addresses to the throne; and this session (1756) was remarkable for an address of thanks to his majesty, for maintaining, and rendering permanent, the general tranquillity of Europe, at a time when war was kindling in almost every quarter of the world."

To the conduct of this war Mr. Pitt was called, as secretary of state, and head of the administration. He had long signalized himself as a bold, eloquent, and energetic speaker, and he soon proved himself a most able and spirited minister. In this war the English in Europe, in Asia, and America, achieved wonders: they were every where victorious: almost all the possessions of the French in North America and in India fell into our hands; and at the battle of Minden, in Germany, seven thousand of our countrymen defeated an army more than ten times as large. The English for some time bore the increasing burdens of warfare with cheerfulness; and rendered, by every means in their power, the just tribute of praise to the talents and activity of the minister. But at length, glutted almost with victory succeeding upon victory, they began to reflect upon the probable advantages that might result from a continuance in war, when it was evident that the conquests made in Germany must ever be foreign to the real interests of Great Britain; that they were waging an unequal war, and adding new loads of taxes to those already difficult to be borne, for conquests which they could neither preserve nor enjoy. Such were the growing discontents of the people, when the French shewing some disposition to treat for peace, and the charges of the war beginning to amount to eighteen millions a-year, inclined the British ministry to listen to the proposals offered them. A negotiation was accordingly entered upon, but without success. This was in the autumn of the year 1760, and on the 25th day of October, 1760, George II., without any apparent symptoms of disorder, was found expiring in his chamber. He had arisen at his usual hour, intending to

walk out, but being left alone, he was heard to fall down upon the floor; the noise of the fall brought his attendants into the room; he desired, in a faint and faltering voice, that the princess Amelia might be sent for, but before her arrival he expired, in the 77th year of his age, and the 33d of his reign, in the midst of victory, and at that very period, when the universal enthusiasm of conquest began to subside into more sober reflections. The character of this prince will be given under his own name. He was succeeded by his grandson George III., the present sovereign, who ascended the throne with great advantages. He took the opportunity which his first speech to parliament gave him, of appealing to the prejudices and affections of his people. "Born and educated in this country," said he, "I glory in the name of Briton, and the peculiar happiness of my life will ever consist in promoting the happiness of a people whose loyalty and warm affection to me I consider as the greatest, and most permanent security of my throne. The civil and religious rights of my loving subjects are equally dear to me with the most valuable prerogatives of my crown." The first acts of this reign were calculated to convince the people that the war in which they were engaged should be carried on with energy; very brilliant successes, and important conquests, were the result of the plans adopted by Mr. Pitt, who felt himself responsible for almost all public measures. When, however, he found his influence in the cabinet declining, through the supposed intrigues of the earl of Bute, he resigned his high situation, declaring he would no longer lie under the responsibility of measures which he was not allowed to guide. Mr. Pitt retired in October 1761, upon a pension of 3000*l.* per ann. and, at the same time, a peerage was conferred upon his lady. These grants were, by his enemies, held out as proper subjects to excite the popular clamours against the patriotic minister. At first they succeeded, but in a short time an almost general discontent prevailed in the nation, on account of his removal from office, in the midst of a war, which he had conducted with so much honour to himself and to his country, and in a manner that had excited the astonishment of Europe. The war was still pursued with vigour, and the plans of Mr. Pitt, of which the new minister availed himself, led to important victories both by sea and land.

Early in the year 1763, peace was agreed upon, and of so little importance had the war been to the interests of the English, who had been almost uniformly victorious, and who had acquired by their valour many foreign possessions, that it was agreed a mutual restitution and oblivion should take place, and each party sit down at the end of the war in the same situation in which they began it. The peace excited much opposition, because the terms were thought extremely inadequate to what might have been expected from the numerous and brilliant victories and advantages obtained in the course of a long war. From this period various causes contributed to occasion a spirit of discontent in the nation. On the 30th of April, 1763, three of the king's messengers entered the house of Mr. Wilkes, member of parliament for Aylesbury, and seized his person by virtue of a warrant from the secretary of state, which directed them to seize the authors, printers, and publishers, of a seditious and treasonable paper, entitled the North Britain, N<sup>o</sup> 45. This work contained strictures on his majesty's speech, and Mr. Wilkes was suspected to be the author. He was accordingly arrested, examined, and closely imprisoned, which gave rise to discussions on the legality of general warrants, which were in the end declared illegal, and a gross violation of the liberty of the subject. (See WARRANTS, General.) Mr. Wilkes was for this and other publications expelled the house,

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house, and in 1764 a sentence of outlawry was issued against him.

In 1765, under the administration of Mr. George Grenville, an act was passed for laying a stamp-duty on the British colonies of North America. This kindled a flame in that quarter of the globe, which finally led to a separation of the colonies from the mother country, and established the independence of America. (See AMERICA and UNITED STATES.) In the year 1768 Mr. Wilkes returned to England, was prosecuted, convicted, and fined in the sum of 1000*l*. He carried with him the voice of the people, whose cause he was supposed to vindicate, and was again elected member for Middlesex; and was again expelled. After the expiration of the term of his imprisonment, in the year 1771, he was elected sheriff of London, and afterwards chosen member for the county of Middlesex, when he was permitted quietly to take his seat; and in the year 1775 he was elected lord mayor of London, an office which he executed to the satisfaction of his fellow-citizens. In 1783 all the declarations, orders, and resolutions of the house of commons, respecting his election for the county of Middlesex, were ordered to be expunged from the journals of that house.

In the year 1772 the clergy petitioned the parliament for relief in matters of subscription to the 39 articles, praying to be restored to their undoubted right of interpreting scripture for themselves, without being bound by any human explanation of it, or being required to acknowledge by subscription or declaration, the truth of any formulary of religious faith and doctrine whatever, excepting the Holy Scripture itself. The petition was presented by sir William Meredith, who, with other members favourable to the principle, enforced it by many arguments drawn from the principles of toleration. It was, however, rejected by a large majority. A bill was shortly after brought into the house to prevent the descendants of his late majesty from marrying without the consent of his majesty, his heirs, and successors, which was carried very rapidly through both houses, and passed into a law. A petition was now presented by the dissenters, praying to be relieved from the hardship of subscribing to the articles of a church to which they did not belong. This petition was received, and a bill brought into the house founded upon it, which was carried by a large majority in the commons, but which was rejected in the house of lords. From this period the whole interest of the country was turned to the contests with America, to which we have already referred. The enormous expences occasioned by this war excited much and almost general discontent among the people, who began to call aloud for an economical reform in the various departments of the state. Meetings were held in various counties of the kingdom, at which great numbers of freeholders were present, who agreed to petition the house of commons, "that before any new burdens were laid upon the country, effectual measures might be taken by that house to inquire into, and correct the abuses in the expenditure of the public money; to reduce all exorbitant emoluments; to rescind and abolish all sinecure places, and unmerited pensions; and to appropriate the produce to the necessities of the state." In the beginning of the year 1780 these petitions were taken into consideration, and some trifling reforms took place. In some instances, the minister, lord North, was left in a minority, and in many others he was obliged to use every exertion to carry his measures. In a very full house, and by a small majority, certain officers under the crown were excluded from having seats in the house of commons: this they hoped to follow by other arrangements favourable to the rights of the people; but, in a short interval, the

minister was enabled to apply arguments not generally understood, but strongly suspected, which gave him a preponderance in the house, and which enabled him to stop the progress of reform. The people were dissatisfied, and a spirit of discontent prevailed in almost every part of the kingdom. About this period, the hardships which individuals, professing the Roman Catholic religion, had laboured under, awakened the consideration of the liberal part of the people: and some persons of high consideration in the state undertook their cause, and fully expected they should obtain for them that relief which the nature of their case required. The Catholics presented a dutiful and loyal address to the king, containing the strongest assurances of affection and fidelity to his person and the civil government of the country. This address, which was drawn up with great care, and which contained sentiments of the most unexceptionable nature, was signed by several Roman Catholic peers, and 63 commoners of rank, fortune, and influence in the country. The advocates of the cause were aware that the prejudices of the lower classes were hostile to an extension of the privileges of the Catholics, whom they had been accustomed to regard as persecutors from principle, and as desirous of subverting the Protestant faith. But sir George Saville made a motion for the repeal of certain penalties which were attached to the profession of the Catholic religion. He was seconded in his exertions by Mr. Dunning, who laid before the house an account of the statutes still existing against the Catholics, by which, among other grievances, it was made high treason in any native of these realms to teach the doctrines or perform divine service according to the rites of that church; the estates of persons educated abroad in that persuasion were forfeited to the next Protestant heir; a son, or any other, the nearest relation being a Protestant, was empowered to take possession of his own father's or nearest kin's estate, during their lives; a Roman Catholic was disabled from acquiring any legal property by purchase. In consequence of these and such like representations, the motion made in favour of the Roman Catholics was received without a dissenting voice, and a bill in pursuance of its intent was brought in and passed both houses. This act seemed to give little offence to persons of any class in England, but in Scotland it excited much indignation, riots ensued, and some houses and chapels were destroyed. The contagion at length reached England: a number of persons assembled themselves together with a view of promoting a petition to parliament for a repeal of the late act in favour of the Papists, and they assumed the title of "The Protestant Association." Of this association lord George Gordon was the president: who, at the head of 50,000 men, presented a petition to the house of commons on the 2d day of June 1780. At first the petitioners behaved with order and decency, but they soon became violent against the members of the two houses who had been friendly to the cause of toleration, some of whom narrowly escaped with their lives. From this time till the 7th of June, London was the scene of the most atrocious crimes: houses, chapels, and prisons, were broken open, plundered, and burnt. In one night, and at the same hour, it is said, there were 36 buildings on fire. Attempts were made on the bank, but such precautions had been taken as to render that place invulnerable. At length by the exertions of the military, who killed and wounded great numbers of the rioters, the tumult was suppressed, and the metropolis restored to order and tranquillity. Numbers were afterwards tried for aiding and abetting in these scenes; some were convicted and executed, and others acquitted; and the president lord George Gordon

Gordon was committed to the Tower on a charge of high treason, for which he was afterwards tried and found "Not Guilty."

War continued to rage, and from America it had spread to almost every part of the world, and the English found themselves engaged in a contest with France, Spain, and Holland: but in the beginning of the year 1762 the opposition succeeded in forcing ministers to a pacification. Peace was accordingly concluded, but not such a peace as met the general wishes of the people, and those who had made it were obliged to resign their places to the famous coalition ministry under lord North and Mr. Fox. By the latter a bill was brought into parliament, for newly regulating the government of the East India Company, which occasioned a great ferment in the country, and which finally drove the author of it, and his party from the helm, who were succeeded by the late Mr. Pitt and his friends. One of the first acts of this minister was a new East India bill, which was passed by a great majority: and shortly after, he became the advocate of parliamentary reform, a cause which he had espoused before he came into place, and which he pledged himself to use his utmost endeavours to carry into effect. His plan was rejected, and from that time he never seriously attempted to realize the expectations which he had excited among the friends of liberty. The next important measure which he introduced to the notice of parliament was the proposal of a sinking fund to be applied towards discharging the national debt. (See DEBT, national. Sinking Fund, &c.) We shall also refer our readers to his public administration: to the article REVOLUTION, French, for the various occurrences that took place in this country from the year 1788; to the article SLAVE Trade for an account of the proceedings on that subject to its final abolition: to the article TEST act for the attempts made in this reign to obtain a repeal of those obnoxious laws, &c. &c. Henry's Hist. Rapin. A.G. Regia. Hume. Belsham. Biog. Brit. &c.

ENGLAND, *Little, beyond Wales*, in *Geography*, is a portion of country lying along the south-western coast of South Wales, inhabited by the descendants of a colony of Flemings; who came over from Flanders, and settled here in the reign of king Henry I. Camden says, the occasion of their emigration was an inundation of the sea, by which a great part of the Low Countries was overflowed. But it has been stated, with more probability, that it was the policy of that wise monarch to place a people opposite in their language, manners, and opinions to the Welsh, to assist in his favourite project—the subjugation of the country. Another colony from the same country was incorporated with the first, in the time of Henry II., to which occasionally were added numerous Anglo-Normans, and others from the English army. At first these people were confined to the comot of Rhos, which district still more particularly retains the name of Little England beyond Wales. But their numbers increasing in the course of time, they soon spread along the whole coast, from the lordship of Comes to the mouth of the river Tave. And this part of the principality is still divided into two districts, denominated Englishery, and Welshery. The latter, occupied by the original inhabitants, contains the cantreves of Comes, Cilgerran, part of Arberth, and Dewisland. The former comprises the remainder of Arberth, and the cantreves of Rhos, Castell-Martins, and Dogleddy; and is inhabited by the descendants of the Flemings. Like their ancestors, they are a hardy, industrious, and adventurous race. The dispositions of the two people are equally striking

and adverse. While the Welsh are hot, easily irritated, and obstinately tenacious; these are not easily provoked, are averse to contention, and avoid litigation. Both are distinguishable by their mode of dress, manner of living, the style of their buildings, particularly in their churches; and the names they respectively give to places. All these strongly point out the line of demarcation between them. In the Welshery, not a word of English is heard spoken, while in the next village within the Englishery, not a word of Welsh. The language of the latter district is not much different from the common dialect of England, except in some parts of Rhos and Castle-Martin. The two people avoid all commerce as much as possible, mutually considering each other in a degrading light; and even a pathway will divide them in the same parish. To such an extent is this personal detestation carried among the lower classes, that a matrimonial connection between the opposite parties is considered by both an unfortunate event. The Flemings, however, eventually proved a blessing to Wales, as well as England; by their introduction of the woollen manufactures. And a work, which proves their industry and improving spirit, is yet visible. It is a road of great extent made by them, and still called Fleming's way. Evans's Tour in South Wales.

ENGLAND, *New*, comprehending the *Northern* or *Eastern States* of North America, lies around the great bay which sets up N.W. between cape Cod and cape Sable, between 41° and 48° N. lat., and between 1° 30' and 10° 15' E. long. from Philadelphia, and is bounded N. by Lower Canada; E. by the province of New Brunswick and the Atlantic ocean; S. by the same ocean and Long-island Sound; and W. by the state of New York. It lies in the form of a quarter of a circle; its W. line beginning at the mouth of Byram river, which discharges itself into Long-island Sound at the S.W. corner of Connecticut, lat. 41°, runs a little E. of N. until it strikes the 45th degree of latitude, and then curves to the eastward, almost to the gulf of St. Lawrence. Its extreme length is about 626 miles; its breadth is very unequal, from 100 to 200 miles; containing about 72,000 square miles. This grand division of the UNITED STATES comprehends the states of Vermont, New Hampshire, Massachusetts (including the district of Maine), Rhode Island, and Providence Plantations, and Connecticut; which see respectively. The climate of New England is salubrious, as we may infer from the longevity of its inhabitants; one in seven living to the age of 70 years, and about one in thirteen or fourteen to 80 years and upwards. The most prevalent winds are the N.W., W., and S.W.; but the E. and N.E. winds, which are insalubrious, occur frequently at certain seasons of the year, particularly in April and May, on the sea-coasts. The weather is less variable than in the middle, and especially the southern states, and more so than in Canada. The extremes of heat and cold are, according to Fahrenheit's thermometer, from 20° below to 100° above 0; the medium being from 48° to 50°. The quantity of water which annually falls in New England is from 42 to 48, and yet they suffer here more from drought than in England, where the annual quantity of water is estimated at about 24 inches. Hence it is inferred that the atmosphere is remarkably dry, and thus some have accounted for its singular salubrity. Winter commonly commences, in its severity, about the middle of December; sometimes earlier, and sometimes not till Christmas. The diseases most prevalent in New England are alvine fluxes, St. Anthony's fire, asthma, atrophy, catarrh, colic, inflammatory, slow, nervous, and mixed fevers, pulmonary consumption, quinsy, and rheumatism. The gene-

## ENGLAND.

ral condition of the New Englanders, which precludes the luxury of the rich and the extreme distress of the poor, affords them an exemption from a variety of diseases, to which a greater degree of inequality might expose them. This country presents to the traveller a great variety of surface, consisting of extensive plains, intermixed with vallies of different breadths from 2 to 20 miles, and with mountains of different elevations. Although it may be deemed, upon the whole, to be high and hilly, its mountains are comparatively small, and run nearly N. and S., in ridges parallel to one another. The westernmost range begins in the county of Fairfield, and, passing through the counties of Litchfield and Berkshire, unites with the Green mountains at Williamstown, in the N.W. corner of the Massachusetts, being separated only by the narrow valley of Hoosack river. The highest part of this range is Toghkonuck mountain in Egremont, the south-western corner of the same state. Over this mountain, elevated probably more than 3000 feet above the ocean, runs the boundary between Massachusetts, Connecticut, and New York. The second range is that of the *GREEN mountains*; which see. The third range has the same commencement with the second at New Haven, in a delightful eminence called the East rock, and passing through the counties of New Haven, Hartford, and Hampshire, extends into Canada. The Blue hills in Southington, mount Tom, which is the principal eminence, mount Holyoke, and mount Toby in Sunderland, are the principal summits of this range S. of New Hampshire. This range, which is precipitous and romantic, crosses Connecticut river just below Northampton and Hadley in Massachusetts. The south or eastern range begins at Lyme in Connecticut, and forms the eastern boundary of the Connecticut valley, until it unites with the last-mentioned range in the county of Hampshire; but is less distinctly marked by eminences than the others. The chief single mountains are Saddle-mountain in Massachusetts, computed to be about 4000 feet above the sea, Watchfett in the county of Worcester, Ascutney in the state of Vermont, Monadnock in New Hampshire, and the White mountains in the same state, of which the highest summit is Mount Washington, probably between 10,000 and 11,000 feet above the ocean, and the highest land in the United States. This mountain is covered during a great part of the year with snow, and is seen in fair weather at the distance of 90 miles from the sea, and 160 from its base. New England abounds in cataracts and cascades; those of the White mountains being singularly romantic and beautiful. The principal rivers of New England are the Schoduck, Penobscot, Kennebeck, Amaricoggin, Saco, Piscataqua, Merrimack, Parkers, Charles, Taunton, Providence, Thames, Connecticut, Hoosstonuck or Stratford, Onion, La Moille, and Missisconi. The largest of these are Penobscot, Kennebeck, Merrimack, and Connecticut. The chief lakes are Champlain and Memphremagog, lying partly in Vermont and partly in New York; Winnipisogee and Umbagog in New Hampshire; Sebago, Moosehead, Willeguaguagun, and Chilmacook or Grand lake in Maine. The most important and useful harbours are those of Machias, Frenchman's bay, Wiscasset, Portland and Wells, in Maine; Piscataqua in New Hampshire; Newbury port, Salem, Marble head, Boston, Provincetown, and New Bedford, in Massachusetts Proper; Newport, Bristol, and Providence, in Rhode island; and New London, New Haven, and Black rock, in Fairfield, in Connecticut. Burlington bay is the most considerable harbour in lake Champlain, on the Vermont shore.

The soil of New England is diversified by every variety from a lean and barren sand to the richest clays and loams.

The hills are covered with a brown loam intermixed with gravel, which is favourable to the production of grafs, and in the western parts of the country, of wheat, and all other kinds of grain and fruits suited to the climate. Clayey soils, when well manured, are very productive. A rich loam, varying towards clay, is prevalent in Connecticut, and is favourable to every kind of cultivation. Sand is generally found on the plains; and the yellow pine plains, which are commonly a mixture of sand and gravel, are friendly to every production that does not require a richer soil. The white pine plains are usually covered with loam, and these, as well as some of the last-mentioned in the same condition, are uncommonly fertile. The vallies are a rich mould; and the intervals, bordering the various streams, are generally sands formed by earth deposited by the floods in the spring, and are of the richest quality.

New England, generally speaking, is better adapted for grazing than for grain, though a sufficient quantity of the latter is raised for home consumption, if we except wheat which is largely imported, particularly into Massachusetts, from the middle and southern states. Indian corn, rye, oats, barley, buck-wheat, flax and hemp, generally succeed very well. Fruits of every kind, which suit a temperate climate, may be obtained in abundance. The summer heat brings to perfection peaches, apricots, and nectarines. Orchards of apple-trees cover a considerable part of the whole country, and cyder is the common drink of the inhabitants. Pears, plums, cherries, currants, gooseberries, whortleberries, blackberries, bilberries, &c. abound. Perry is made in some parts of the country, but not in great quantities. Various species of the hickery and hazle-nuts, and chestnuts are plentifully furnished by the southern half of New England. Gardening is much improved, and its productions are daily varying and increasing. But the most important production of New England is grafs. The high and rocky ground is in many parts covered with clover, and affords excellent pasture to some of the finest cattle in the world. The quantity of butter and cheese made for exportation is very great. Considerable attention is now paid to the raising of sheep; and the wool is in a state of progressive improvement. The principal exports of New England are mackarel, salmon, cod, and other fish; whale-oil and whale-bone, timber, malts, boards, staves, hoops and shingles; horses, mules, salted beef, and pork, pot-ash, pearl-ash, flax-seed, apples, cyder, corn, butter, and cheese. New England is the most populous part of the United States; it contained, in 1790, 1,009,522 persons, and, in 1800, 1,233,011. The great body of the inhabitants consists of landholders and cultivators of the soil. As they possess in fee simple the farms which they cultivate, they are all naturally attached to their country; and the cultivation of the soil makes them robust and healthy. New England has been not unaptly denominated a nursery of men; and hence are annually transplanted into other parts of the United States, thousands of its natives. They are almost universally of English descent; and to this circumstance, as well as to the general attention that has been paid to education, it is owing that the English language has been preserved among them in so considerable a degree of purity. The New Englanders are generally tall, stout, and well-made. Their education, laws, and situation serve to inspire them with high notions of liberty, of which they are jealous, in some cases perhaps, to excess. A chief foundation of freedom in the New England states is a law, by which intestate estates descend to all the children, or other heirs, in equal proportion; and hence it happens, that the people of New England enjoy an equality of condition, that is unknown in any

other part of the world. Besides, they are frugal and industrious, and inured to habits of sobriety and temperance. Learning is more generally diffused among all ranks of people in New England than in any other part of the globe; which is owing to the excellent establishment of schools in every town. In these schools, generally supported by a public tax, are taught the elements of reading, writing, and arithmetic; and in some of the principal and more wealthy towns they are pursuing education in a higher scale, and introducing the superior branches of grammar, geography, and other sciences. Literature is also encouraged and diffused by the circulation of newspapers and periodical publications, and by the establishment of reading societies and parochial libraries. Curiosity, and a desire of information, are very prevalent in New England; and the common people, it is said, are distinguished by attention and civility to strangers. In former times the New Englanders were strict, to a degree of punctiliousness, in their observance of the sabbath; and hence, as well as from some other traits of their character, they acquired the character of a superstitious and bigotted people. But since the war, a catholic, tolerant spirit, occasioned by a more enlarged intercourse with mankind, has much increased, and is becoming universal. "If," says Dr. Morse, "they do not go beyond the proper bounds, and liberalize away all true religion, of which there is very great danger, they will counteract that strong propensity in human nature which leads men to vibrate from one extreme to its opposite." A custom still prevails, transmitted to the present race from their ancestors, of annually celebrating fasts and thanksgivings. In spring, the governors of the several New England states, Rhode island excepted, proclaim a day of fasting, humiliation, and prayer; and in autumn, after harvest, they appoint a day of public thanksgiving. Many of the women in New England are handsome. Those, who have enjoyed the advantages of a good education, and they are numerous, are genteel, easy, and agreeable in their manners, and are sprightly and sensible in their conversation. And it is a laudable practice among the females to accustom themselves at an early period to the management of domestic concerns with neatness and economy. Employment at the needle, in cookery, and at the spinning-wheel, is honourable. The women in country towns manufacture the greater part of the clothing of their families. Their linen and woollen cloths are strong and decent. Among the amusements of the people of New England is dancing, of which the young people of both sexes are extremely fond. The athletic and healthy diversions of cricket, foot-ball, quoits, wrestling, jumping, hopping, foot-races, and prison-bars, are universally practised in the country, and some of them in the most populous places, and by people of almost all ranks. Of the religion of the New Englanders, and of the provision that is made for the support of it, we shall have occasion to speak under the article UNITED STATES. We shall here merely observe, that the constitution of these states provides against the making of any law respecting an establishment of religion, or prohibiting the free exercise of it. And in the constitution of the respective states, religious liberty is a fundamental principle. Without the aid of civil power, religion is left to be supported by its own evidence, by the lives of its professors, and the almighty care of its divine author. Its public teachers are maintained by an equal tax on property, by pew-rents, monies at interest, marriage and burial fees, small glebes, land rents, and voluntary contributions. Christians profess their religion under various forms, and with different ideas of its doctrines, ordinances, and precepts. Accordingly the sects of Christians are very numerous and

various. Of these sects, those that are called Congregationalists are the most numerous. In New England there are about 1200 congregations of this denomination. Next to these in respect of number are Presbyterians. In New England there are between 40 and 50 Protestant episcopal churches.

New England owes its first settlement to religious persecution; and the inhabitants of this country are descended from those that were called Puritans in the mother-country. The first attempt to form a regular settlement in this part of America was at Sagadahock in 1607; but in the following year, the whole number of those who survived the winter returned to England. The first company, that laid the foundation of the New England states, planted themselves at Plymouth, in November, 1620; though this appellation was given to North Virginia by Capt. Smith in August 1614. The founders of the colony consisted of 101 persons. In 1640, the importation of settlers ceased, in consequence of the abatement of persecution by the change of affairs in England. At this time the number of emigrants, who had traversed the seas in 298 vessels, from the commencement of the colony, amounted to 21,200 men, women, and children, forming, perhaps, about 4000 families. In 1760, the number of inhabitants in Massachusetts bay, New Hampshire, Connecticut, and Rhode island, amounted, probably, to half a million. Morse.

ENGLANTERIA, in *Botany*. See EGLANTERIA.

ENGLECHERIE, ENGLSCHERY, or *Engleschere*, a term of great import among our ancestors, though now obsolete; properly signifying the quality of an Englishman.

If a man were privately slain or murdered, he was anciently accounted francigena (which comprehended every alien, especially the Danes) till englecherie was proved, *i. e.* till it was made to appear that he was an Englishman. Bracton, lib. iii.

The origin of the custom anciently subsisting among the Goths in Sweden and Denmark, was thus: king Canutus, having conquered England, at the request of his nobles, sent back his army into Denmark, only reserving a guard of Danes for his person; and made a law, that if any person was murdered, he should be supposed to be a Dane, if he was not proved to be an Englishman by his parents or kindred, and, in default of such proof, if the murderer was unknown, or had made his escape, the township where the man was slain should be charged to pay sixty-six marks into the exchequer: or if by reason of the poverty of the township, that sum could not be raised from thence, it was to be paid by the hundred. After this law, which was continued by William the Conqueror, for the like security to his own Normans, whenever a murder was committed, it was necessary to prove the party slain an Englishman, that the penalty of sixty-six marks might not be charged on the village. The manner of proving the person killed to be an Englishman was by two witnesses, who knew the father and mother, before the coroner, &c. This practice was abolished by statute 14 Edw. III. cap. 4. See MURDER.

ENGLESQUEVILLE, in *Geography*, a small town of France, in the department of the Lower Seine, 18 miles S.W. of Arques. There are several small towns of the same name, in the department which comprises the former province of Normandy.

ENGLISH, in a general sense, something that relates to the country or people of England. Thus we say, the English crown, English copperas, English names, English money, English measures, English weights, &c. The sweating-sickness is called by foreigners *Judor Anglicanus*, the

English sweat. (See *SUDOR-ANGLICUS*.) Dr. Cheyne calls the vapours the English malady.

ENGLISH *Borough*. See *BOROUGH*.

ENGLISH *Cape*, in *Geography*, a cape on the south coast of Newfoundland. N. lat. 46° 49'. W. long. 53° 29'.

ENGLISH *Cove*, a harbour, or bay, on the coast of New Ireland, about 3 or 4 miles from cape St. George.

ENGLISH *Drops*, *Gutta Anglicanae*. See *DROP*.

ENGLISH *Harbour*, in *Geography*, one of the best harbours in the island of Antigua, situated on the S.W., a little to the E. of Falmouth harbour. It is well fortified, and has a royal navy-yard and arsenal, with conveniences for careening ships of war. N. lat. 17° 8' 25". W. long. 61° 27' 30".

ENGLISH *Point*, a cape in the river St. Lawrence, on the coast of Canada. N. lat. 49° 40'. W. long. 61° 45'.

ENGLISH *Reach*, a reach in the straits of Magellan, about 3 leagues broad, between cape Gallant and cape Holland.

ENGLISH *Road*, a road in the island of Eooa, or Middleburgh, in the South Pacific ocean, having 25 fathoms water. S. lat. 21° 20'. W. long. 174° 34'.

ENGLISH *School of Engraving*. See *ENGRAVING*.

ENGLISH, or the ENGLISH *Tongue*, the language spoken by the people of England; and with some variation, by those of Scotland, as well as part of Ireland, and the rest of the British dominions.

The English is of Gothic, or Teutonic extraction; this was the root or stock upon which several other dialects have been since grafted, particularly the Latin and French. See *TEUTONIC*, &c.

The language anciently spoken in our island was the British, or Welsh, which was common to the Britons and Gauls; and which still subsists, in more or less purity, in the principality of Wales, the islands and Highlands of Scotland, part of Ireland, and some provinces of France, particularly Bretagne, and very lately subsisted in the county of Cornwall. (See *CORNISH Language*.) This language was the Celtic or Gaelic, which is said to be very copious and expressive, and is, probably, one of the most ancient languages in the world. It once obtained in most of the western regions of Europe: and now remains in the different dialects of the Irish, Welsh, and Erse. See *CELTS*.

As the Roman empire, extending itself towards the western parts of Europe, under Julius Cæsar, Claudius, and Domitian, came to take in Gaul and Britain, the Roman tongue became propagated therewith; all the edicts, &c. relating to the public affairs, being designedly wrote in that language.

The Latin, however, it is certain, never got so much ground, or prevailed so far in England, as in Lombardy, Spain, and the Gauls; partly on account of its great distance from Rome, and the small resort of Romans hither; and partly, because the entire reduction of the kingdom was not effected till so late as the reign of Claudius, when the empire was on the declining hand, and the new province was forced to be soon deserted by its conquerors, called to defend their territories nearer home.

Britain, thus left naked, became an easy prey to the Angli, or Anglo-Saxons, a strolling nation, from Jutland and Norway, who took an easy possession thereof about the year 450, much about the time that the Franks, another German nation, entered Gaul. The Gauls and Franks, it seems, at length came to terms; found means to unite into one nation; and thus, the ancient Gaulish, with its mixture of Latin, continued the prevailing tongue, only farther intermixed with the Francic or lingua Franca of the new inmates; but the Britons were more constant, and determined absolutely to refuse any such coalition: they had embraced Christianity,

Augustine being sent from Rome to convert them about the year 570, and their competitors were heathens; rather than admit of such an union, they therefore chose to be shut up, with their language, in the mountainous parts of Cambria or Wales.

The English Saxons, thus left absolute lords, changed every thing; their own language, a dialect of the Gothic or Teutonic, and altogether distinct from the Celtic, was now fully established, and laid the foundation of the present English tongue: and the very name of the country was henceforth to be Anglo-Saxon. (See *ANGLO-SAXON*.) The new language remained, in good measure, pure and unmixed, till the Norman invasion: the attempts of the Danes, and the neighbourhood of the Britons, indeed, wrought some lesser innovations therein; but, in the main it preserved itself; for, as to the Danes, their language was, probably, from the same root with the Saxon; and it did not long remain a distinct tongue in any part of England, but was blended with the Anglo-Saxon, and formed a particular dialect of that language.

This Dano-Saxonic dialect was principally spoken in the kingdom of Northumberland, where the Danes chiefly prevailed: that the Anglo-Saxon language was spoken in the S.E. parts of Scotland at this time is undeniable. When Edgar the Peaceable, king of England, yielded Lothian to Kenneth II. king of Scotland, A.D. 975, it was on these express conditions; that the people of that country should still be called Englishmen, be governed by the English laws, and be allowed to speak the English language.

Edward the Confessor, however, who had lived long in France, might possibly bring in a little mixture of the dialect of that country.

But William I. and his Normans, having got possession of England, an alteration was soon attempted: the conquest was not complete, unless the Conqueror's language, the French and Franco-Gallic, were introduced; and accordingly all his acts, diplomas, edicts, pleadings, and other judicial matters, were written, &c. in that tongue.

But his attempts proved unsuccessful; the number of Normans he brought over being very small in comparison of the English, with whom they were incorporated, they lost or forgot their own language, sooner than they could make any change in the English. This, however, did not hinder, but, by the endeavours of the Conqueror, abundance of French words, though many of them of Latin original, crept into the English; and many English words, by degrees, grew out of use. Hence it happened, that the English, which was spoken afterwards, and continues to be spoken now, is a mixture of the ancient Saxon and this Norman French, together with such new and foreign words as commerce and learning have in the progress of time gradually introduced. See *ANGLO-SAXON*.

Upon the whole it appears, that the Teutonic dialect is the basis of our present speech. It has been imported among us in three different forms, the Saxon, the Danish, and the Norman; all which have mingled together in our language, so that it may be supposed to exist in three different periods, viz. Anglo-Saxon, Danish-Saxon, and Norman-Saxon. The first begins with the Saxon invasion, the second with the Danish, and the third with the Norman. Some have made the properly English period to commence with Edward I., towards the close of the 13th century; others have referred it to the 14th century; and others again have thought that it ought rather to commence with Henry VIII.; as the controversies of the Reformation were in fact the cause which then abolished the Norman dialect of the court, and introduced the present common English to our worship and

## ENGLISH.

to our literature. Many of our words are also plainly derived from the Latin. But these were not introduced directly from the Latin; whereas most of them, probably, entered into our tongue through the channel of that Norman French, which William the Conqueror introduced. For, as the Romans had long been in full possession of Gaul, the language spoken in that country, when it was invaded by the Franks and Normans, was a sort of corrupted Latin, mingled with Celtic, to which was given the name of Romanish; and as the Franks and Normans did not, like the Saxons in England, expel the inhabitants, but, after their victories, mingled with them; the language of the country became a compound of the Teutonic dialect imported by these conquerors, and of the former corrupted Latin. Hence, the French language has always continued to have a very considerable affinity with the Latin; and hence, a great number of words of Latin origin, which were in use among the Normans in France, were introduced into our tongue at the conquest: to which, indeed, many have been since added, directly from the Latin, in consequence of the great diffusion of Roman literature throughout all Europe. From the influx of so many streams, or the junction of so many dissimilar parts, it naturally follows that the English, like every compounded language, must necessarily be somewhat irregular. We cannot expect from it, says Dr. Blair (*Lectures, &c.* vol. i.) that correspondence of parts, that complete analogy in structure, which may be found in those simpler languages, which have been formed in a manner within themselves, and built on one foundation. Hence, it has but small remains of conjugation or declension; and its syntax is narrow, as there are few marks in the words themselves that can shew their relation to each other, or, in the grammatical style, point out either their concordance, or their government, in the sentence. Our words having been brought to us from several different regions, straggle, if we may so speak, asunder from each other; and do not coalesce so naturally in the structure of a sentence, as the words in the Greek and Roman tongues. But these disadvantages, if they be such, of a compound language, are balanced by other advantages that attend it; particularly by the number and variety of words with which such a language is likely to be enriched.

As to the origin and etymology of many of our words, Dr. Wallis lays it down, that such words of German original as we have, in common with the French, are to be reckoned as our own, rather than as words borrowed from them; and that the old Gaulish words, common to the French and the Welsh, which are found in our language, have been likewise taken from the Welsh, rather than from the French. Hence, also, the same author accounts why the names of the divers sorts of cattle are Saxon; as ox, cow, calf, sheep, hog, boar, deer, &c. and yet that their flesh, when prepared for food, is French; as beef, veal, mutton, pork, brawn, venison, &c. the Norman soldiers not concerning themselves with pastures, parks, and the like places, where such creatures are fed and kept, so much as with markets, kitchens, feasts, and entertainments, where the food was either prepared, sold, or eaten.

Under Henry II., Dr. Swift observes, the French made a still greater progress; because of the large territories he possessed on that continent, both from his father and his wife, which occasioned frequent journeys thither, with numerous retinues, &c. And for some centuries after, there was a constant intercourse between France and England, by the dominions we possessed there, and the conquests we made; so that the language, two or three hundred years ago, seems to have had much more French than at present.

Besides this alteration from the conquerors, the language in process of time underwent several others; and at length came to have numerous words and phrases of foreign dialects ingrafted into it, in lieu of the ancient Saxon; particularly, by means of negotiations and commerce with other nations; by the marriages of royal families; by the affectation of many writers, in most ages, who are fond of coining new words, and altering the usual forms of speech, for the greater delicacy; and, by the necessity of framing or borrowing new words, according as new things and inventions turn up: and by such means was the old Anglo-Saxon converted into the present English tongue. See **ANGLO-SAXON**.

Having traced the rise and progress of our language historically, we think it may be no inconsiderable amusement to represent by actual examples the several successive changes and stages it has passed through, to arrive at its present perfection: in order to which, we shall make use of the collections of the ingenious Mr. Greenwood.

From the Saxon invasion, we have no memorial extant of the language for 250 years: the oldest Saxon writing in being is a gloss on the evangelists, written in the year 700, by Eadfride, bishop of Holy Island; in which the three first articles of the Lord's Prayer run thus:

"Uren Fader thic arth in heofnas, sic gehalgud thin noma, to cymeth thin ryc. Sic thin willa sue is in heofnas, and in eorþo," &c. See **ANGLO-SAXON**.

Two hundred years after, in the year 900, the same was rendered thus:

"Thu ure Fader the eart on heofinum, si thin nama gehalgod; cum thin ric. Si thin willa on eorþan swa, swa on heofinum."

In the following age it was turned thus in the Saxon Homilies, said to be translated by king Alfred:

"Fæder ure thu the earth on heofenum, si thin nama gehalgod, to be cume thin rice, gewurthe thin willa on eorþan swa, swa on heofinum," &c.

About the year 1160, under Henry II., near which period the Saxon began to assume a form in which the beginning of the present English may be discovered; it was thus rendered by pope Adrian, an Englishman, in rhyme:

"Ure Fader in heaven rich,  
Thy name be hayled ever lich,  
Thou bring us thy michell blisse:  
Als hit in heaven y-doe  
Evar in yearth beene it also," &c.

About 100 years after, in the time of Henry III., it was translated thus:

"Fadir that art in heaven blisse,  
Thin helge nam it wurth the blifs,  
Cumen & mot thy kingdom,  
Thin holy will be it all don,  
In heaven and in erdh also," &c.

Two hundred years after, under Henry VI., it was rendered thus:

"Our Fadir that art in hevenes, halewid be the name,  
thi kingdom come to thee, be thi will don in eerthe, as in hevene."

Dr. Hickes furnishes an extraordinary specimen of the English, as spoken in the year 1385, in his *Theaur. Liter. Septent.* which we shall the rather amuse the reader with, as it is on this very subject, the English tongue; and contains not only the history, but the reason of the changes and differences therein:

"As it is knowe how meny maner peple beeth in this lond; there beeth also so many dyvers longages and tonges. Notheles Walsche men and Scots that beeth nought medled  
with

with other nations, holdeth wel nyh hir first longage and speche: but yif the Scottes that were sometime confederat and woned with the Pictes drawe somewhat after hir speche; but the Flemynge that woneth in the weste side of Wales, haveth left her strange spech, and speketh Saxonliche now. Also English men, they had from the bygynnyng three maner speche; northerne, sowerne, and middel speche in the middel of the londe, as they come of three maner of peple of Germania: notheless by comyxtion and mellynge first with Danes, and afterwards with Normans, in meny the contrary longage is apayred [corrupted.] This apayryng of the burthe of the tunge is bycause of tweie thynges, oon is for children in scole agens the usage and maner of all other nations, beeth compelled for to leve hire own longage, and for to construe hir lessons and here thynges in French, and so they haveth sethe Normans come first into Engelond. Also gentlemen children beeth taught to speke Frenche from the tyme that they beeth rokked in here cradel, and kunne speke and play with a childes broche; and uplondische men will linke hymself to gentilmen, and fondeth with great beynesse for to speake Frenche to be told of. Hit seemeth a greet wonder how English men and her own longage and tonge, is so dyverse of foun in this oon ilond; and the longage of Normandie is comlynge of another lond, and hath oon manner foun amonge alle men that speketh hit arigt in Engelond. Also of the foresaid Saxon tonge that is deled [divided] a three, and is abide scarceliche with few uplondische men, is greet wonder. For men of the est, with men of the west, is, as it were, under the same partie of hevne acordeth more in fownygne of spech, than men of the north, with men of the south. Therefore it is that Mercii, that beeth men of myddel Engelond, as it were parteners of the endes, understondeth better the side longages northerne and souterne, than northerne and souterne understondeth either other. All the longage of the Northumbers, and specialliche at York, is so scharp, slitting and frotyng, and unschape, that we souterne men may that longage unneth understonde. I trow that that is by cause that they beeth nyh to strange men and nations, that speketh strongliche, and also bycause that the kinges of Engelond wonneth alwey fer from that cuntry," &c.

The first of our authors, who can properly be said to have written English, was sir John Gower, who, in his Confession of a Lover, calls Chaucer his disciple.

How the English stood about the year 1400, may be seen in Chaucer, who refined and improved it very considerably; though he is charged with the affectation of mixing too many French and Latin words with his English, and by that means, with too much altering and corrupting the primitive language.

In the year 1537, the Lord's Prayer was printed according to the following version:

"O oure Father which arte in heven, halowed be thy name: let thy kingdome come, thy will be fulfilled as well in erth as it is in heven," &c.

Where the reader will observe the diction almost brought to the present standard; the variations being principally in the orthography. See an historical view of the progress of the English language, with specimens at different periods, from the age of Alfred to that of Elizabeth, in the Introduction to Dr. Johnson's English Dictionary, vol. i. fol:

Spencer, who lived in the same age, contributed not a little to the improvement and refining of the tongue: he threw aside abundance of the outlandish ornaments, and wrote a purer English, yet with more elegance and variety than had been known before. He was succeeded by

Shakespeare, Ben. Johnson, lord Bacon, Milton, Cowley, Waller, Tillotson, Dryden, Addison, and Pope, &c. whose works are in every body's hands; and by whom the language has been transmitted to us under all its present advantages.

The perfections ascribed to the English, and also in a degree superior to any of the modern tongues, are, 1. That it is very strong and significant; to which our finely compounded words, formed on the model of the Greeks, do not a little contribute.

This may also be partly ascribed to the national character of the people who speak it, from which language is apt to receive its predominant tincture. Thus, the gravity and thoughtfulness, as well as the strength and energy, of the English, and also the gaiety and vivacity of the French, are sufficiently impressed on their native tongues. However, though the English language possesses distinguishing strength and energy, it is naturally prolix, on account of the great number of particles and auxiliary verbs, which in the use of it we are obliged constantly to employ; and this prolixity must, in some degree, enfeeble it. We seldom can express so much by one word as was done by the verbs, and by the nouns, in the Greek and Roman languages. Our style is less compact; our conceptions being spread out among more words, and split, as it were, into more parts, make a fainter impression when we utter them. Notwithstanding this defect, as our language abounds in terms for expressing all the strong emotions of the mind, and we have the liberty, in a greater degree than most nations, of compounding words, it may be esteemed to possess considerable force of expression; more especially when we compare it with the other modern tongues, though much below the ancient. The style of Milton alone, both in poetry and prose, affords sufficient evidence, that the English tongue is far from being destitute of nerves and energy.

2. The English language is copious; of which Mr. Greenwood gives us instances in the word striking; which we have above thirty different synonymous expressions for; as to *smite, bang, beat, bash, buffet, cuff, hit, thump, thwack, slap, rap, tap, kick, spurn, box, yerke, pummel, punch, &c.* and the word *anger*, for which he enumerates above forty. So we say *to seeth* or *boil* flesh, *stew* prunes, *poche* eggs, *coddle* apples, *bake* bread; for which expressions, *to seeth, stew, poche, coddle, and bake*, the Latins, with all the boasted copia of the tongue, have only one word, *coquere*; and the French, as much as they abound with terms of cookery, not many more; the word *cuire* serving indifferently for *seething, boiling, baking, stewing, and coddling*.

Indeed, few languages are more copious than the English. In all grave subjects especially, historical, critical, political, and moral, no writer can justly complain of the barrenness of our tongue. We are also rich in the language of poetry. Our poetical style differs widely from prose, not in point of numbers only, but in the very words themselves; which shews what a stock and compass of words we may select and employ, suited to different occasions. In this respect we are infinitely superior to the French, whose poetical language, if it were not distinguished by rhyme, would not be known to differ from their ordinary prose. It is chiefly, however, on grave subjects, and with respect to the stronger emotions of the mind, that our language displays its power of expression. But, in describing the more delicate sentiments and emotions, our tongue is not so fertile; and we must acknowledge its inferiority to the French. This is, perhaps, the happiest language for conversation in the known world; but, on the higher subjects of composition, it is much excelled by the English.

3. The English language is not destitute of flexibility. This power of accommodation to different styles and manners, so as to be either grave and strong, or easy and flowing, or tender and gentle, or pompous and magnificent, as an author's genius prompts or occasions require, is a quality of great importance both in speaking and writing. This property of a language seems to depend upon three things: its copiousness; the different arrangements of which its words are susceptible; and the variety and beauty of the sound of those words, so as to correspond to many different subjects. The Greek possessed this property in a super-eminent degree; the Latin was, in this respect, inferior to it; and among the modern tongues, the Italian possesses flexibility in a greater degree than the French; and though our language has less of it than the Italian, it possesses a considerable degree of this quality. If any one will consider the diversity of style which appears in some of our classics; that great difference of manner, for instance, which is marked by the style of lord Shaftesbury, and that of dean Swift; he will perceive, in our tongue, such a circle of expression, such a power of accommodation to the different taste of writers, as redounds not a little to its honour.

4. Some have challenged to the English language the praise of being musical and harmonious; and in this respect Mr. Dennis makes no scruple to assert it superior even to the French. This, which some may think strange, he proves hence, that we have blank verse which is harmonious by mere force of numbers and quantity; whereas the French have long ago desisted from all pretensions to poetical numbers, without the assistance of rhyme.

It may be added on this last head, from Mr. Wellstead, that the English has many measures, the iambic and trochee, for instance, in common with the Greek and Latin; an advantage arising from the variation of the accent; and that rhyme is peculiarly natural to it, varying itself to the ear with excessive sweetness; not to mention the cæsuras, pauses, transpositions, and numberless other graces, which the English versification is capable of, probably beyond every other living language.

The English has, indeed, been reproached on account of its deficiency in harmony of sound; but the charge has been extended too far. The melody of our versification, and the power which our language possesses of supporting poetical numbers, without any assistance from rhyme, afford sufficient proof that our language is far from being unmusical. Next to the Italian, our verse is the most diversified and harmonious of any of the modern dialects; and far exceeds the French in variety, sweetness, and melody. Mr. Sheridan has shewn, in his Lectures, that we abound more in vowel and diphthong sounds than most languages; and these, too, so divided into long and short, as to afford a proper diversity in the quantity of our syllables. Our consonants, he observes, though they appear crowded to the eye on paper, often form combinations not disagreeable to the ear in pronouncing; and, in particular, the objection which has been made to the frequent recurrence of the hissing consonant *s* in our language is unjust and ill-founded: for this letter frequently loses the hissing sound, especially in the final syllables, and is transformed into a *z*, affording a sound on which the ear can rest with pleasure. After all, it must be allowed, that strength and expressiveness, more than grace and melody, are the distinguishing properties of the English tongue. It is a remarkable peculiarity of English pronunciation, that the accent is thrown farther back, or nearer the beginning of a word, than is done by any other nation; and the general effect of this practice of hastening the accent is to give a brisk and a spirited, but at

the same time a rapid and hurried, and not very musical, tone to the whole pronunciation of a people.

5. The English tongue is, without doubt, the most simple in its form and construction of all the European dialects. It is free from all intricacy of cases, declensions, moods, and tenses. The words are subject to fewer variations from their original form than those of any other language. Its substantives have no distinction of gender, except what nature has made, and but one variation in case. Its adjectives admit of no change at all, except what expresses the degree of comparison. Its verbs, instead of running through all the varieties of ancient conjugation, suffer no more than four or five changes in inflection. By the help of a few prepositions and auxiliary verbs, all the purposes of significance in meaning are accomplished; while the words commonly preserve their form unchanged; which structure, though it has its disadvantages in point of elegance, brevity, and force, contributes to facility. However, bishop Lowth has observed in the Preface to his Grammar, that the simplicity and facility of our language occasion its being frequently written and spoken with less accuracy. See GRAMMAR, LANGUAGE, STYLE, SYNTAX, &c.

Some object to the English, that it consists too much of monosyllables; which others represent as an excellence, because it argues a greater antiquity, if what Salmastius says be true: *Certum quippe est, linguas omnes, quæ monosyllabis constant, cæteris esse antiquiores;*" he adds, that the "ancient Greek abounded herein, as appears from the ancient poets, and such as affected antiquity." *De Re Hellenist.*

But we have a farther advantage from our monosyllables, *viz.* "conciseness;" as we are hereby enabled to express more matter in the same compass of letters than any other modern tongue. The only thing we suffer by it, is, something in point of softness and numbers; and yet we have verses composed wholly of monosyllables, that do not want harmony; as that of Creech,

"Nor could the world have borne so fierce a flame."

Others object to our language, that it does not equal the softness, the delicacy, of the more southern languages, of France, Spain, and Italy. It seems to retain somewhat of the Gothic roughness of the people who framed and introduced it; the soil and climate it was planted in, not tending much to mellow and refine it.

To this purpose does Dr. Swift speak, who accounts for the effect hence, that the Latin tongue was never in its purity in our island; and besides, it was removed, in its imperfect state, before it could have time to incorporate with the language of the country, and subdue and soften it, as it did in the other provinces of France and Spain, &c. But it is to be observed, that, upon the whole, this, supposing it true, does not lie as an objection against the language, but the people: our manners are also less polished than some of our neighbours; we are not yet arrived at that pitch of moleste, of delicateffe, of soupléffe, which we censure in them; and it is but just our language correspond with the rest of our character.

Mr. Wellstead is of opinion, that the English language is not capable of a much greater perfection than it has already attained. We have trafficked, he observes, with every country for the enriching of it; the ancients and moderns have both contributed to give it splendour and magnificence; the fairest cyons that could be had from the gardens of France and Italy, have been grafted on our old stocks, to refine the savageness of the breed; we have laid

aside most of our harsh, antique words, and retained few but those of good and sound energy: the most beautiful polish is at length given to our tongue that it will bear, without destroying and altering the very basis and ground work of it; its Teutonic rust is worn away, and little or nothing is wanting either of copiousness or harmony. He goes on to argue the maturity and perfection of the English, from another very extrinsic principle, *viz.* by comparing the time and circumstances of the improvements made since the first refiners of it; with those of the Greek, Latin, French, and other tongues that confessedly have risen to their height.

Every civilized nation, that author thinks, has its classical age; and he suggests, that the English are not far from it. So that what remains to be done for the English tongue, should not be to advance, but to fix it where it is, and prevent its declining. There is, in effect, a point of perfection, which when a language has once arrived at, it cannot exceed, though it may degenerate from it; and thus it happened to the two finest languages that the world has known.

It may seem odd to talk of fixing so unstable a thing as language: the Greek liturgies of St. Basil, and St. Chrysostom, still used in that church, the one for solemn, the other for common days, have been a long time unintelligible to the people; so much has the vulgar Greek degenerated from its original purity! Polybius testifies, that the articles of truce between the Romans and Carthaginians could scarcely be understood by the most learned Roman antiquaries, three hundred and fifty years after the time in which they were made. In effect, from the days of Romulus to those of Julius Cæsar, the Latin was perpetually changing; and what was written three hundred years before Tully, was as unintelligible in his time as the English and French of the same period are now; and these two have changed as much since William the Conqueror, in about eight hundred years, as the Latin appears to have done in a like term.

Whether our language will decline as fast as the Roman did, may admit of some doubt; there being many circumstances in the affairs of the nation, which contributed to that speedy corruption, that may not, in all probability, find place among us. The French for about two centuries past, has been polishing as much as it will bear; and it appears to be now declining, by the natural inconstancy of that people, and the affectation of some late authors, to introduce cant words, which is the most ruinous corruption in any language. But without some such consideration there does not seem any absolute necessity, why a language should be perpetually changing.

We find examples to the contrary: from Homer to Plutarch, are above a thousand years; and so long, at least, Dr. Swift thinks, we may allow the purity of the Greek; the Grecians spread their colonies round all the coasts and islands of Asia Minor, and the Ægean sea, where the language was preserved entire for many ages after they themselves became provinces to Rome, and were over-run by the barbarous nations. The Chinese have books in their language above two thousand years old; neither have the frequent conquests of the Tartars been able to alter it. And the German, Spanish, and Italian, have admitted few or no changes for some ages past.

On such considerations, that author moved the then prime minister, the earl of Oxford, to establish a society, or academy, for the settling, and ascertaining, the purity of our tongue; to set a mark on the improprieties which custom has made familiar, to throw out vicious phrases and words, to correct others, and perhaps retrieve some others now grown obsolete, and to adjust the orthography, pointing, &c.

Without some such means, he complains that the fame any writer can expect will be so short and scanty, as by no means to be a sufficient motive to call forth, and engage a man to exert his genius. Our language is chiefly confined to these two islands; and it is hard our authors' fame should be limited in time as well as place. Were it not for the Bible and Common-Prayer, we should hardly have been able to understand any thing written about two centuries ago.

It is a melancholy reflection, that Petrarch still speaks good Italian; whereas Chaucer, who lived an hundred years later, is not to be understood by an English reader without a Saxon and French glossary. And what security has Dryden himself, while things continue on their present footing, that he shall not, in a like space of time, become as obsolete as Chaucer is?

Grammars and dictionaries, with whatever care and judgment they are composed, will prove but a feeble stay to a fleeting language, unless they have some extraordinary sanction and authority. And, what is to be lamented, such writings have contributed to the corruption almost as much as the perfection of our tongue.

Dr. Gill, Ben Johnson, and Hexham, it is certain, by forcing the English tongue to the Latin method, have clogged and perplexed it with abundance of useless precepts concerning cases, genders, and declension of nouns, tenses, moods, and conjugations of verbs, and other things which our language has nothing to do with. Nor have even Dr. Wallis, Greenwood, &c. though sensible of the fault in those others, been able wholly to keep clear of it themselves. See *STYLE*.

*ENGLISH Town*, in *Geography*, a small village in the north-western part of Monmouth county, in New Jersey, on the road from Princeton to Shrewsbury; 21 miles from the former, and six W. of Monmouth court-house.

*ENGLISH Turn*. See *DETOUR Des Anglois*.

*ENGLSTAIN*, a town of Germany, in the archduchy of Austria; six miles N.W. of Zwettl.

*ENGONASIS*, *Ἐγωνασις*, in *Astronomy*, Hercules; one of the northern constellations. See *HERCULES*.

*ENGOUTED*, in *Falconry*, is said of a hawk's feathers, when they have black spots in them.

*ENGRAFTING*. See *GRAFTING*.

*ENGRAILED*, or *INGRAILED*, in *Heraldry*, (from the French *grêle*, hail) is when a thing is represented with its edges ragged, or notched, semi-circularly, as if broken by something falling on it. See *INDENTED* and *INVECTED*.

Spelman expresses it in Latin by *imbricatus*; others by *ingrediatus*; and others by *striatus*.

*ENGRAPPLE*. This is a device in use principally in *Naval Warfare*, where it is intended to retain an enemy's vessel in some particular position, especially for the purpose of boarding. When an opportunity may offer of grappling across a ship's bows, or stern, so as to allow raking her fore and aft, the battle is usually but of short duration; it being almost impossible for a crew to stand to their guns while subject to so destructive a fire. Generally we find, that when a commander is intent on boarding his opponent, he has his yard-arms supplied with small grapnails, which being lowered down at pleasure, among the enemy's rigging, hook therein, and thus prevent her from retiring to avoid the boarders. Sometimes poles, having long bars at their ends, are used for the same purpose; these are chiefly managed by the forecattle-men, and have their butts lashed to the *davit*, or to the *cat-head*. Whatever contrivance may be in use for engrappling, it is expedient that the implement be every where sufficiently solid or firm to retain its hold,  
and

and to resist the hatchet, otherwise the enemy would speedily cut them away: thus, all grap-nails should be suspended by means of chains, passed through blocks at the yard-arms; nor should the tackle, by which they are acted upon, be hauled tight until the points of the grap-nails may be firmly hooked among the shroud-hawfers, or some such substantial part of the enemy's rigging, which he could not, with safety to his masts or yards, cut away. Where it is practicable, a very strong chain should be passed round the whole of the shroud-hawfers of that mast, respectively, opposite which the vessel is engrappled; or, if that be too hazardous, the chain-plates may be secured in a similar manner. It is evident, that were the former to be all included, the enemy must cut away every support on that side his mast, before he could extricate himself: in the latter instance, as the chain-plates are of iron, and very substantial, nothing but the chain, whereby they are embraced, giving way, could afford the means of separation.

Sometimes ships become fortuitously engrappled, by the flukes of their anchors hooking among the rigging of the vessels opposed to them: this, however, is seldom permanent; for as the engrappling arises from accident, so does a lift, or heave of the sea, ordinarily set the parties at liberty, either by tearing away whatever hitches upon the fluke, or by causing the latter to unhook itself. Where the sea runs high, this is often the case; exposing both vessels to the most imminent danger, and always causing considerable damage. Hence, it should ever be considered by a commander, how far the safety of his ship may become questionable in the attempt to approach his opponent, when there is much swell. The practice of engrappling is, indeed, but rarely resorted to in ships of the line, or even by frigates; but is extremely common among privateers abounding in men, and intent upon bringing an engagement to a very speedy issue, so as to save their hulls and rigging from such damages as might compel them to seek a port wherein to re-fit.

**ENGRAVER**, one who practises the art of engraving. See **ENGRAVING**.

**ENGRAVER'S Act**, the act for securing the copy-right of engraved prints. That engravers might enjoy the fair advantages arising from the exercise of their own talents, and that the public at large might in due time succeed to such advantages, an act of parliament was passed in the 8th year of Geo. II., "for the encouragement of the arts of designing, engraving, and etching historical and other prints, by vesting the properties thereof in the inventors and engravers, during a time therein mentioned."

After thus vesting the property for the term of *fourteen* years, to commence from *the day* of publication, it enacts that the name of the proprietor shall be engraved on each plate; "and any printfeller, or other person, who shall engrave, etch, or in any other manner copy, and sell, or cause to be engraved, etched, or copied and sold, in the whole or in part by varying, adding to or diminishing from the main design, or shall print, reprint, or import for sale any such print or prints, "without the consent of the proprietor first had and obtained in writing," signed by him in the presence of two credible witnesses, or knowing the same to be so printed, &c. without consent of the proprietor, shall publish, sell, or expose to sale, then such offender "shall forfeit the plate or plates" on which such print or prints are or shall be copied, and all and every sheet or sheets (being part of or whereon such print or prints are or shall be so copied or printed) "to the proprietor or proprietors of such original print or prints," who shall forthwith destroy the same. And further, that every such offender shall forfeit five shillings for every print which shall be found in his custody, either

printed and published, or exposed to sale; one moiety to the king and the other to the informer.—*Note*, These penalties do not extend to purchasers of plates from the original proprietors (s. 2.): and actions for offending against this act must be brought within three months (s. 3.)

The act of 7 Geo. III. c. 38. after reciting that the preceding act had been found ineffectual, enacts, that the original inventors, designers, or engravers of any print, "map, chart, or plan, or any other print whatsoever," taken from any picture, drawing, or sculpture, are entitled to the benefit and protection of the recited and present acts; and by (sect. 7,) *extends* the rights intended to be secured by this and the former act to the term of *twenty-eight* years.

A subsequent act (passed in the 17th of Geo. III.) states, that the former acts have not answered the purposes for which they were intended, and that it is necessary for the encouragement of artists, that further provisions shall be made. It therefore enacts, that if any engraver, etcher, printfeller, or other person, shall, within the time limited by the aforesaid acts, engrave or etch, or cause, or procure to be engraved or etched, or worked, in "mezzotinto, or chiaro-scuro, or otherwise," copy; or who shall print, re-print, or import for sale, any copy of any historical print, or any portrait, conversation, landscape, or architecture, map, chart, or plan, or any other print whatsoever, which hath, or have been, or shall be engraved, etched, drawn, or designed "in any part of Great Britain," without the express consent of the proprietors first had and obtained in writing, then every such proprietor shall and may in a special action on the case to be brought against the offending party, recover *such* damages as a jury on the trial of such action, upon the execution of a writ of enquiry thereon, "shall give or assess," together with "double costs of suit."

The following are the most important cases which have subsequently occurred, and which are introduced to shew the legal construction which has been put upon the aforesaid act of parliament, by magistrates of high authority.

In the sittings after Hilary term, 25 Geo. III. before lord chief justice Mansfield, Sayer brought an action against Moore for pirating sea charts. The charts which had been copied were four in number, which Moore had made into one large map. It appeared in evidence that the defendant had taken the body of his publication from that of the plaintiff; and that the plaintiff had originally been at great expence in procuring materials for these maps; but it was also proved that the defendant had made many material alterations and improvements thereupon. Lord Mansfield's address to the jury upon this occasion is remarkable and important. "The rule of decision in this case, he observed, is a matter of great consequence to the country: in deciding it we must take care to guard against two extremes equally prejudicial; the one, that men of ability who have employed their time for the service of the community, may not be deprived of their just merits, and the reward of their ingenuity and labour: the other, that the world may not be deprived of improvement, nor the progress of the arts be retarded: the act that secures copy-right to authors, guards against the piracy of the words and sentiments; but it does not prohibit writing upon the same subject, as in the cases of histories and dictionaries: in the first a man may give a relation of the same fact, and in the same order of time; in the latter an interpretation is given of the identical words: in all these cases, the question of fact to come before a jury, is whether the alteration be colourable or not; there must be such a similitude as to make it probable and reasonable to suppose that one is a transcript of the other; so in the case

of prints, no doubt different men may take different engravings from the same picture. The same principle holds with regard to charts: whoever has it in his intention to publish a chart, may take advantage of all prior publications; there is no monopoly of the subject here, any more than in the other instances, but upon any question of this nature the jury will decide whether it be a servile imitation or not. If an erroneous chart be made, God forbid it should not be corrected, since it thereby becomes more serviceable and useful for the purposes to which it is applied: but here you are told that there are various and very material alterations: the defendant therefore has been correcting errors, and not servilely copying. If you think so, you will find for the defendant; if you think it a mere servile imitation, and pirated from the other, you will find for the plaintiff." [Verdict for defendant.] No action therefore lies in future for publishing sea charts on an improved and more useful principle, even though many of the lines should be copied from older charts.

In Easter term, 10 Geo. III. Wil. 60. Sayer lost his action against Dicey for copying and selling a print, because though the year of our Lord, wherein the original plate was published was engraved thereon, the day of the month was not.

In Michaelmas term, 33 Geo. III. 5 T. R. 41. an action was brought against Symonds and others, for pirating a portrait of the countess of Huntingdon. Bowyer was the original proprietor, and had assigned his right through Fittler to Thompson, by whom the action was maintained. On becoming possessed of the plate, Thompson had inserted his own name in the inscription instead of Bowyer's, "preserving the original date" of 26th day of August, 1790; but the objection started on this ground was over-ruled by the court, and the plaintiff obtained a verdict and 10*l.* damages.

ENGRAVING, ENGLISH, *Origin and Progress of.* In England, the art of engraving has gradually arisen from its rude mechanical practice by our British ancestors. It may be said to be indigenous to our soil. Roman and Saxon improvements have from time to time been engrafted; and more recently, shoots from the engraving of Germany, Italy, and France, have also been engrafted by the enterprise of individuals, not by the wisdom or authority of the state, on the original stock. It will probably excite the surprise of posterity, that this art has hitherto been cultivated, (if such might be called cultivation,) in Great Britain in no other way, though Great Britain be the chosen seat of modern commerce; and engraving, being in its nature the most commercial of those arts which administer to calm and elegant enjoyment, affords the most efficient means of diffusing through the world a just and general taste in the fine arts, and, consequently, in those numerous branches of manufacture which are derived from, and sustained by, those arts.

That it was rudely practised in this island from a very early period, may be seen by the remains of instruments of war, and other antiquities which have been found in the Celtic and Saxon tumuli; these, as is observed by that intelligent artist and antiquary, the late Mr. Strutt, frequently bear marks of the graver, or of some tool which cannot have been very dissimilar; and the numerous coins of Cunobelin must satisfy every inquirer of the early British existence of this species of engraving, an art which was probably introduced from Rome during the reign of that prince.

The art of die-engraving could not have existed alone; it implies the existence of other modes of ingenuity; and, with the use of money, must have spread the ameliorating influence of art. But all rising ingenuity, and even this mode of engraving, appears to have sunk under the Roman and

Danish ravages, which soon succeeded. Excepting these coins, those of Carausius, and a few others of less certain date, and the war implements mentioned above, faint indeed are the traces of British engraving, until the time of Alfred the Great.

"Under the protection of that excellent monarch," says Strutt, "the arts begun to manifest themselves in a superior degree. He not only encouraged such artists as were in England at the time, but invited others from abroad; and the works of the Anglo-Saxon goldsmiths, who were the principal engravers of that day, were held in the highest esteem upon the continent as well as in their native country. The caskets which they made for the preservation of the relics of saints, and other pious purposes, were ornamented with precious stones and engravings in so excellent a style, as to excite the admiration of *all who saw them.*" Wonder is the concomitant of ignorance. There is, however, yet preserved in the Museum at Oxford a very valuable jewel of gold, adorned with enamelling, and a kind of fillagree work, in the midst of which is seen the half figure of a man, which is supposed by Hickee and Wootton to represent Jesus Christ, and conjectured by Strutt to be rather intended for St. Cuthbert. The back of this curious remnant of antiquity is ornamented with engraved foliage and flowers. From the unquestionable testimony of its own legend, this jewel is known to have been made at the command of Alfred the Great, and was one of the very few articles he could have carried with him when he retreated to the isle of Athelney; where it has since been found.

Archbishop Dunstan is said to have worked in the precious metals, frequently adorning his works with images and letters which he engraved thereon. Osbern (his biographer) calls him the first of engravers; but it has been emphatically observed, that he who could add the title of *Saint* to the name of Dunstan, would not hesitate to call him a Raphael in painting, or an Audran in engraving; and the specimen of his drawing, which is still preserved in the Bodleian library, leaves us little to regret in the entire loss of his engravings.

The engraving of Dunstan and his contemporary *workmen*, was doubtless the degenerate issue of the art which the patronage of Alfred had called forth. In the tempest of war, and the night of ignorance and superstition that succeeded, scarcely a glimmering of its light was seen. The mingled work of the engraver, chaser, enameller, and goldsmith, which is seen in Alfred's jewel, entirely disappeared, but die-engraving, as it afforded the means of issuing money, became to the Anglo-Saxon princes an art of necessity, because inseparable from the existing system of government and polity; and hence, while other arts pined and perished, it was enabled to survive the inclemency of those barbarous ages, and to preserve and transmit to better times the art of the engraver.

Laws of Athelstan and Canute, appointing the number of minters who shall reside in their principal towns, and for the punishment of those who shall dare to adulterate the coinage of the realm, are still extant, and may be read in Thwaite's observations on Anglo-Saxon and Anglo-Danish Coins.

It may be presumed, that the art of die-engraving, and the weak tenures by which landed property was previously held, gave rise to the engraving and the use of seals. Before their introduction, Ingulphus expressly says, that lands were sometimes disposed of by word of mouth; sometimes by laying a turf of the land granted with religious solemnity on the holy altar; and in other instances the lord gave to the tenant a sword, bow, helmet, arrow, or drinking-horn

to certify the transfer; a drinking-horn is mentioned by Lewis as being in the possession of a Mr. Pyfsey of Berkshire, on which was engraven, "I king Knoute (Canute) have given thee this horn to hold thy land by."

In corroboration of the idea that the numismatic process suggested both the manner of engraving and of *using* seals, we may mention that the matrices of ancient English seals, of which some few are yet remaining, are formed with the same kind of cutting and punching implements which were used by the die-engraver; they were of brass, as were probably the dies of that period, and from that time to the present, metal seals have continued to be executed with the same implements used in the same manner, or with no other variations than have been produced by the gradual improvement of society operating on the peculiarities of individual talent: also (see SEAL-ENGRAVING,) that they were at first impressed as money is coined, namely, by a forcible blow, and that *lead* received the impression; and from the testimony of Ingulphus it further appears, that seals were by no means common in England before his time; he says that, "the Normans, disliking the English manner of ratifying their chirographs (or charters), ordered them to be confirmed by impressions on *wax* from the special seals of the parties concerned. The only seal in England that is known to have been impressed on wax before this period, is that of Edward the Confessor; but as this prince is known to have received his education in Normandy, the singularity is accounted for.

From this time the use and sacredness of seals went on increasing in the public estimation, so that before the lapse of a century, their devices, forms, and sizes, appropriated to the different ranks in society, were gradually settled. Even the etiquette of sealing on different coloured waxes, was ascertained with sufficient scrupulosity.

An impression from the seal of Anselm, the primate, has been copied, and is introduced (see *Pl. of British Engravings*, fig. 2.) from which some idea may be formed of the Anglo-Norman style of design and engraving, as compared with what had preceded it. The archbishop has lost his head, and has probably been decapitated in effigy, on account of his cropped hair, and by some of those resentful partizans of the long and curled locks, which were fashionable at the court of William Rufus. Against long hair, Anselm had preached with some apparent success, and with a vehemence which is highly extolled by Eadmer, his companion and secretary; but it has been observed, that though the clergy at that time could overturn thrones, and had authority sufficient to send above a million of men on *their* errand, to the deserts of Asia, they could not prevail against certain fashions.

It appears, that some argillaceous substance, apparently pipe clay, has in this instance been mixed with the wax of the seal; which has afterwards been painted either with a view to its better preservation, or to give the true tint of the rank of a Norman archbishop. The small folded parchment to which it is appendant, or rather which depends from it (see the engraving) is a grant of church land. The prolixity of modern legal forms might blush before its brevity.

About, or soon after, the time now under our observation, a new species of engraving, more simple in its nature than those which had preceded it, was either introduced into or invented in England; of which there is scarcely an old country church of any consequence, but affords some curious specimens, and England more than any other nation in Europe. The brass plates on our old sepulchral monuments are executed entirely with the graver; the shadows, where

shadowing is attempted, being expressed by lines (or strokes,) strengthened in proportion to the required depth of shade, and occasionally crossed with other lines a second, and in some instances a third time, precisely in the same manner as a copper plate is engraven that is intended for printing. On other occasions a mere outline only has been cut.

These engraved effigies are often found cemented on those horizontal tomb-stones, which form part of the pavement within the churches, where the feet of the congregation, which kept the lights bright by friction, filled the incisions with dust, and thus darkened the shades; very neat or exquisite workmanship was not therefore aimed at, and is not to be expected; yet some of these engravings bear no small evidence of the abilities of those by whom they were performed, and considering the dark period during which they were executed, are entitled to more praise than many engravings which have been subsequently produced. The engraver's style of drawing the human figure differs little from that of the contemporary illuminators of missals, and though the hands, feet, and other nudities are rarely tolerable, the stiffness of the draperies does in many instances bear considerable resemblance to the tissued and embroidered vestments of the entombed abbots, and other dignitaries of the early Catholic church; while the faces occasionally display attempts not altogether successful, as it should seem, at individual portraiture.

That which has been selected as a specimen of this mode of engraving, is from the tomb of William de Fulbourn, in Fulbourn church, Cambridgeshire, and is copied, with the permission of the Messrs. Lyfons, from their *Magna Britannia*. William de Fulbourn was appointed a baron of the exchequer in the year 1328, and is here represented (see the *Plate of English Engravings*, fig. 3.) "with the effigies of an ecclesiastic in a richly ornamented cope, under an elegant canopy, engraved on brass," &c. &c. See Lyfons's *Cambridgeshire*, p. 64. Part of the canopy and finale have been omitted on account of the smaller dimensions of our plate. The pattern of the embroidery, as may be seen, is far from being inelegant, and the recurring initials, (W. F.) roses, and other ornaments, are engraved with no inconsiderable care and neatness.

Philosophers have remarked how frequently man has stumbled or stooped short at the very threshold of improvement. From the time of the Crusades, Great Britain has been in possession of an art of engraving from which ink might have been delivered, and consequently impressions multiplied, either on the same vellum on which books were formerly written, or, since the middle of the 12th century, on paper itself: yet until about the year 1460, no man appears to have thought of delivering ink from the incisions of the graver.

Whether accident or design, and whether Italy or Germany had the honour of giving birth to an invention, of which three centuries and a half have not served fully to develop the important consequences to society, has been much disputed among the curious. Mr. Strutt is among the number of those who have pursued these inquiries with considerable diligence. After discussing the German and Italian pretensions, he at length brings forward an impression from an engraved brass plate in his own possession, which he conceives to be English, and which he thinks *may* claim the palm of early date. Its style of art is truly that of the early German school, and also that of the engravers of the English sepulchral brasses of the fifteenth century; yet from another circumstance, which shall be mentioned anon, the writer of this article is led to think that Mr. Strutt's

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Strutt's plate, and the tenor of his reasoning thereupon, are more curious, than his conclusion is well founded.

Mr. Strutt says, "no one seems to have supposed that we could lay even the most distant claim to a rivalry (much less to a priority) with respect to the early practice of engraving, with any of the continental nations famous for the arts. But when we consider how many engravers we had in England, about the time in which the discovery of taking impressions from copper-plates was made, as the many monumental engravings remaining in our churches to this day sufficiently testify, (and a little examination of these early specimens of the art will prove how well they were adapted to the purpose of printing,) we shall readily conceive that if they did not themselves discover this mode of multiplying their works, they would at least have instantly adopted it, as soon as the knowledge of such an invention had reached them."

There can be little doubt of the antiquity of the engraving here produced; and that it was made for the purpose of printing, the letters being reversed upon the plate sufficiently prove. So that if it should be urged, though we see no kind of reason for such a supposition, (this is surely more than strict criticism will concede to Mr. Strutt,) that the plate itself was executed abroad, at the command of some English devotee, it must at least be granted that the mode of taking impressions from it was understood in England, or the plate could not have been of any use to the owner of it; and that the engraving was the work of some English artist, or executed at the design of some English personage; no one, I conceive, will doubt on examining the contents of the inscriptions. They consist of particular invocations to saints, comprehended in seven compartments, the initial letters of each invocation or prayer being ornamented with the representation of the personages to whom it is addressed." Here follows a particular description of the several compartments.

"The address to the English saints in the fifth petition, plainly, we think, determines the country to which it belonged. The style of the drawing, and the manner in which the little figures are composed, being placed in the initial letters, bear an exact resemblance to the illuminated delineations which we meet with in manuscripts of the fifteenth century, especially towards the commencement of it; and the writing also has every appearance of equal antiquity."

If we should proceed thus far with Mr. Strutt, and admit his reasoning, it will scarcely be practicable to travel with him further, though he be in general, as to matters of fact, an excellent guide. The invocations, which cover the far greater part of the plate, are not in the English, but the Latin language, and Mr. Strutt informs his readers, that they are "evidently stamped upon the plate with small punches, and re-touched afterwards with the graver." Now, no man would cut an alphabet of punches, (or punchcons, as they are sometimes technically termed,) for the sake of engraving, or stamping, such a plate as Mr. Strutt has brought forward, nor would probably any cause of less magnitude than the formation of matrices for an alphabet of moveable types, induce an artificer to bestow the time and pains, necessary to the production of such an alphabet of punchcons. From this single circumstance, the present writer is inclined to refer the engraving in question, in whatever country it may have been executed, to a period subsequent to the invention of moveable types; consequently if it was executed in England, it must have been after the year 1471, when, according to Dr. Middleton,

Caxton had returned from abroad, and began to print books in Westminster Abbey.

Another reason, which does not seem to have presented itself to Mr. Strutt, why the invention of printing with the rolling press from plates of metal cannot, in fairness, be assigned to England, is that to suppose this art to have been known here before the experiments of Finiguerra, we must also suppose that almost a century elapsed between the first and second examples of English copper-plate printing, which is a thing not to be supposed for a moment.

Of the engravings that accompanied an edition of Vesalius's anatomy, which was printed in England in the year 1545, Mr. Ames says, "these plates are some of the first rolling press printing in England." Of these plates, Thomas Geminus, or Gemini, was the engraver: they were not the very first that were published here. "The birth of Mankind, otherwise called the Woman's book," made its appearance in 1540, and contains some small anonymous copper-plate cuts, yet Geminus might possibly have begun his engravings more than four years before the date of their publication: at least he is the first engraver in England of whose name we are in possession, and whose works were printed on paper.

The first edition of Geminus's Vesalius was dedicated to king Henry VIII. He published a translation by Nicholas Udal, of the same work, in 1552, and dedicated it to Edward VI. The translator in his preface says, "Accepte therefore jentell reader, this treatise of anatomie, thankfully interpreting the labours of Thomas Gemini, the workman. He that with his great charge, watch and travayle, hath set out these figures in pourtrature, will most willingly be amended, or better perfected of his own workmanship, if admonished."

Those who have seen the masterly wood engravings to the original Vesalius, published at Padua, in 1542, engravings that were done under the eye, and, as some have said, touched by the hand, of Titian, will perceive that Gemini has left abundant room for admonition: yet the consideration that his work was a first attempt, at once to transplant a new art to England, and to extend the knowledge of anatomy, will probably be received as no unsatisfactory apology for the defects of these engravings.

Gemini lived in Black-Friars: he printed and published other books, among which are a small tract on midwifery, with copper-plate engravings, (which is, perhaps, the same that is mentioned above, under the title of "the Birth of Mankind, &c.") a prognostication relating to the weather, the phenomena of the heavens, &c. decorated with a number of cuts, and another edition of his Vesalius, printed in 1559, and dedicated to queen Elizabeth.

Lord Orford has observed that, "so congenial an art as engraving, when once discovered, could not fail to spread in an age of literature. That accomplished prelate, archbishop Parker, who thought that whatever tended to enlighten and cultivate the human mind, was within his province, seems to have been the most conspicuous patron of the art, in the reign of Elizabeth. He employed, in his palace at Lambeth, a painter and two or three engravers. Of these engravers, the chief was Remigius Hogenbergh, who twice engraved the archbishop's head, which, if Vertue be right, was the first portrait printed in England, from an engraving on copper; Remigius had a brother whose name was Francis, by whose hand is extant a print of queen Mary I. dated in the year 1555. Under it is written "Veritas Temporis Fida." In the set of Saxton's maps, those of Gaul and Belgium are by this artist,

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and he has also engraved *views* both in Bruin's *Civitates Orbis Terrarum*, printed in 1572 at Cologne, and in Abraham Ortelius's *Theatrum Orbis Terrarum*, printed in 1570 at Antwerp. On the foreground of one of the views contained in the latter work, are two figures dressed in the costume of the times, one of which is the portrait of Ortelius himself, (as the inscription beneath informs us); and the other that of Hoefnagle the engraver, who, though a native of Antwerp, was among the first of those who practised the art in England. The map of England in this work was by Humphrey Lhuud of Denbighshire, and that of Spain by Thomas Geminus, whom we have already mentioned. Lord Orford thinks it creditable to England, that we had at this time, "professors worthy of being employed to adorn Flemish editions; Flanders being at that time a capital theatre of arts and learning;" and Ortelius himself commends the English engravers, specifying besides those whom we named, Antony Jenkenfon, and Robert Leeth.

Christopher Saxton deserves mention here, for at once extending the knowledge of our national geography, enlarging the field of engraving, and raising himself to eminence from the condition of a servant. He was a native of Yorkshire, and lived at Tingley, near Leeds, in the service of Thomas Sekeford, esq. master of the Requests, and of the court of Wards. Encouraged by this gentleman, who kindly assisted him with money, Saxton undertook to make a complete set of maps of the counties of England and Wales. Many of the plates he engraved himself, and in others was assisted by Francis Hogenbergh, Nicholas Reynold, and Augustin Ryther. Six years were employed in the work, which commenced in the year 1573. These were *the first* county maps that ever appeared in England, and Thoresby says of that of Yorkshire, which is three feet wide, that it is "the best that ever was made of that county." Ryther had the chief hand in engraving it, and at the corners are views of the city of York, and the port of Hull. These maps are also adorned with the royal arms, and those of the patron "Master Sekeford," and are dedicated to the queen.

In lord Orford's catalogue is a worthless portrait of George Hoefnagle, who engraved about this time a map of Bristol, and a view of the palace of Nonfuch, which, though once so magnificent, is now only known from description and the print of Hoefnagle. He worked entirely with the graver, and, as has already been mentioned, was one of those employed by Ortelius, in his great work, which may truly be called so, when we consider the time when, and the circumstances under which, it was produced.

We have passed over Cole, Bettes, de Brees, and others: and even the names of many of those who served to mark no era in the art of which we are here tracing the progress in England; who neither invented nor introduced a new style, nor distinguished themselves in those which were previously known and practised; we shall pass over them with a general reference to Strutt, Grainger, and lord Orford's catalogue, where their names and the dates of their works may be found, with such lists of their performances as those authors, with the assistance of George Vertue, were able to form or collect.

Notwithstanding the praise of Ortelius, English copperplate engraving retained, for more than an hundred years, much of its original coarseness and vulgarity. The style of Reginald Elstracke, who lived at the close of the sixteenth and beginning of the seventeenth centuries, is occasionally somewhat neater than that of his predecessors, but still desti-

tute of taste. His instrument was the graver, but faint indeed are the mental rays that attended its progress.

Elstracke worked chiefly for the booksellers; and his best works are portraits, which are for the most part, if not entirely, after his own drawings. They are in number at least thirty; and among the best of them are those of sir Philip Sydney, engraved soon after his death, and "BAZILIOLOGIA, or the true and lively Effigies of all our English Kings from the Conquest to the present time" (1618.) His portrait of queen Mary of Scotland is probably, on the whole, his best performance.

Francis Delaram was contemporary with Elstracke. His workmanship, for it can scarcely yet be called art, and certainly not fine art, was somewhat neater than that of Elstracke, but equally tasteless. The squareness or rectangularity of his crossings gives a peculiar dryness to his style of engraving; he drew but indifferently, his outlines are hard, and his draperies heavy. Unless we may except the following plates, which are after his own designs, his portraits are the best of his works. The frontispiece for "Wyther's Preparation to the Psalter," ornamented with emblematical figures, and dated 1619. The frontispiece to "The Seven golden Candlesticks," 1624. "Nero Cæsar, or Monarchie Depraved," 1627; this also is a frontispiece. And the best of his portraits are those of "James the First," an upright whole sheet print, as large as life. "Queen Mary and Queen Elizabeth," small uprights. "Henry Percy, Earl of Northumberland," dated 1619. "Frances, Duchess of Richmond and Lenox," and "Sir Thomas Gresham."

But the family of the Passes, or *de Passes*, of whom the elder came hither from Utrecht, early in the seventeenth century, introduced a better taste, and a neater and more elaborate style of engraving than had hitherto been practised in England.

Crispin de Passe was a man of letters, studious, and of a liberal mind. Holland's *Heroologia* was embellished and published at his expence; and in the preface to a drawing-book, published by him at Amsterdam, in the year 1643, (after his departure from England,) he discovers some knowledge in geometry and perspective; gives directions for the proportions of the human body; for drawing in the academy by lamp light, and for the use of the lay-figure in studying draperies; and details the proportions of horses, lions, and other quadrupeds, and of birds and fishes. In the same preface he says of himself that he applied early to the study of the arts, and mentions Rubens, Bloemart, and other distinguished contemporary artists, as his friends and encouragers: but he appears also to have looked with advantage at the neater productions of the German school of engraving. The following is a tolerably just estimate of his powers as an artist, and is from the pen of the late Mr. Serutt.

"Passe worked entirely with the graver, in a neat, clear style, which has much originality; and, excepting some little stiffness which frequently appears, and the want of harmony with respect to the distribution of the light and shadow, (a fault which prevailed at the time in which he lived,) his best works possess a very considerable share of merit, especially his portraits, many of which he drew from the life; and the far greater part of his historical and emblematical subjects are engraved from his own compositions. He drew the human figure very correctly," (but the proportions and style of his figures are those of the school of Rubens,) "and marked the extremities with a degree of exactness, not usually found in the works of those masters who employed themselves upon small subjects."

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Mr. Strutt should have recollected here, that exquisite examples of delicate marking and elaborate workmanship might then have been seen, and, probably, were seen by Crispin Passe, in the works of the Behams, Penz, and those other German artists who are emphatically termed the *little* masters; particularly in the engravings of Bartholomew Beham, who had studied under Marc Antonio.

The sons of this artist, who were Crispin junior, William, and Simon, and his daughter Magdalen de Passe, followed the instructions and the style, and in some instances surpassed the merits, of their father; though the works of Magdalen, the first female engraver we read of who practised the art in England, are not equal to the best of those of her brethren. In three plates from Ovid's *Metamorphoses*, which she has engraved after pictures by Elsheimer, she has judiciously imitated the style of count Goudt, but has not produced the same forcible effect, nor attained the same exquisite degree of finish. Lists of the numerous portraits and other engravings by this family, may be seen in lord Orford's Catalogue, and Mr. Strutt's Dictionary of Engravers; and in the Royal library at Paris, before the revolution, was a collection of their works in large volumes, of which there were either two or three.

From Simon Passe the art descended to his pupil John Payne. Other engravers were practising in England at the time, but of inferior merit. Payne had caught the mantle of the Passés. Strutt says of him that "he was a man of genius, and though his works are not very numerous, they nevertheless manifest his superior abilities. He was recommended to Charles I., and had a fair prospect of making his fortune; but careless of that as he was of his fame, he neglected his business and died in indigence, A.D. 1647 or 48, before he had reached his 40th year. His chief engravings consist of frontispieces and other book-plates, and portraits. But he also engraved a variety of other subjects, such as landscapes, flowers, &c. His portraits, however, are, in my opinion, by far his best works. Those he executed entirely with the graver in a free open style, so managed as to produce a very pleasing effect. Mr. Evelyn, speaking of this artist, commends him also for a ship which he engraved. This ship, as Vertue informs us, was the Royal Sovereign, built by Phineas Pett. The print was of a prodigious size, and engraved on two plates, being, when joined, three feet long, by two feet two inches high." His best portraits are from Cornelius Janfen.

Having proceeded thus far with the progress in England of the art of engraving on *copper*, it behoves us to attend to the introduction and early progress of that of engraving on *wood*.

The art of engraving, and printing from, blocks of wood, was introduced into England about the same time with the mode of printing with the rolling press from engravings on copper: if, indeed, *wood* were really the material used for those engravings which are called, and generally supposed to be, wood engravings, and which are common from the time of the first promulgation of the art through the sixteenth and the two following centuries, and where the printing ink is evidently delivered from "lines crossing each other," and with the letter-press.

The earliest English engravings of this kind which the present writer has examined, unless those which are published with the mark of Holbein are really by his hand, and were any of them performed after his arrival in this country, are those of Christopher Switzer, who lived at the close of the sixteenth and beginning of the seventeenth centuries. He was probably a German by birth, though here bred in England. Vertue says, he cut a set of the broad seals of England, which

may be seen in the Harleian library, but impressions from the blocks of coins and seals which he cut for Speed's history are not uncommon; and here the remarkable dark crossings occur, and may be particularly observed in the four blocks which are entitled "portraits of the ancient and of the more civil Britons." Speed calls this artist "the most exquisite and curious hand of that age," and he probably was so, if we confine the remark to wood-engraving, and to England. Evelyn says of Switzer's son, who succeeded him in his profession, and was also named Christopher, "we have likewise a Switzer for cutting in wood, the son of a father, who discovered his dexterity in the herbals set forth by Mr. Parkinson, Lobel, and divers other works with due commendation;" which shews that the elder Switzer engraved the blocks of botanical subjects for Lobel's observations, and Parkinson's "Paradisus Terrestris," which was published in 1629.

It may have been perceived that of the fact of dark lines crossing each other, being printed from the surfaces of engraved blocks and with the letter-press, the present writer entertains considerable doubt. His doubt is founded on the extreme difficulty, amounting to impracticability, though not to absolute impossibility, of cutting away the minute lozenges of wood, or interstices between the crossed lines, so as to leave such a surface of dark crossings as must have presented itself to the letter press printers of this period.

To print dark crossings from the incisions of the graver, and with the rolling-press, may be conceived to be comparatively easy: but as printing from the *surface*, and with the letter press, was preferred on account of its superior facility, we are reduced in reasoning upon these engravings, if we suppose them to have been performed on *wood*, to the monstrous absurdity of supposing, that a difficult and tedious, was preferred to a simple and easy process, and that on account of its superior facility!

These considerations have led to the supposition that the prints in question were not taken immediately from the engravings, but from casts of some kind, for which the engravings; on whatever substances they were performed, did but serve as matrices or moulds. Yet wood cannot be cast in moulds: and in the library of Mr. Anthony Carlisle, professor of anatomy to the Royal Academy (whose name is, undesignedly on the part of the author, omitted in a note to the volume of lectures on engraving delivered at the Royal Institution, p. 205.) are two books illustrated with letter press engravings, which appear to contradict the above hypothesis. It may not be impertinent here to transcribe a passage from the *manuscript* of the lecturer.

"I have to regret that this part of the lecture is so little better than a statement of doubts. Since this volume has been in the press, I have seen, in the library of Mr. Carlisle the anatomist, a copy of Johnson's translation of Ambrose Parey's anatomy, printed in 1691, which is illustrated with letter press engravings where dark crossings frequently occur, and in the preface to which the author says, 'the figures in this work are not the same used by my author; but according to those of Bauline, which were used in the work of Dr. Crook.' Upon referring to the latter work, which I found in the same library, and which was printed in 1631, it was evident that the prints were not copies, but impressed from the very same engravings: but there was this remarkable difference which *ordinary* incredulity could scarcely stand against, that in Johnson's work the prints were obviously impressed from some substance which had been *worm-eaten* in the course of the sixty years it had lain by, and which could not therefore have been *metal*." The remainder of this note would be superfluous: the inference is obvious.

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obvious. But, the public must not be led astray, nor must the author of that note let pass this opportunity of controverting himself.

It has since come to his knowledge, and is an undoubted fact, that old lead is not unfrequently found perforated by worms, or by some small animalculæ, which leave behind circular holes of exactly the same kind and size, which we so frequently see in old wooden furniture, books, &c. He resumes therefore his opinion, and indeed a further and more particular inspection of the productions of this kind, of the German school, has confirmed his belief, that the numerous prints produced at this early period in Germany and the Low Countries, which are supposed to be impressed from engravings on wood, are really printed from metal casts.

As Dr. Crook's anatomical work was published but two years after Parkinson's *Paradisus Terrestris*, it is probable that one of the Switzers engraved the anonymous anatomical figures which are the subjects of the above comments. The art of engraving, on whatever substance was then employed to enable the printer to produce dark crossings from the surface of the work, was an exotic transplanted from Germany or the Low Countries, and appears never to have taken root in our soil. It died away with or soon after the Switzers, and has never revived since: for the art of engraving on wood, as practised by the Bewicks of Newcastle and their disciples, and imitators, is to be considered as quite a distinct art. But, for further information on this subject, see **LETTER PRESS ENGRAVING**, and **WOOD ENGRAVING**.

Contemporary with the younger Switzer and with Hollar, of whom we shall presently treat, were Robert VanderVoerft and Lucas Vorsterman, who were rival competitors for public fame, and rivals also in the favour of king Charles I. Charles was the first English monarch who was sufficiently sensible of the beauty of engraving, and of the popular and important purposes to which it might be applied, to appoint an engraver royal. The king took care to see that the title was not worthlessly thrown away, in mere kindness to a courtier, and Voerft was the first artist on whom that honour was conferred. He was a native of Holland, and in what year he came hither is uncertain. He was an able draftsman, and hatched his drawings with pen and ink, as was the general custom of the artists, particularly the engravers, of that period. A drawing of this kind performed on vellum, and of which the subject was the Madonna with the infant Jesus and St. John, he had the honour of presenting to the king, for whom he afterwards engraved a portrait of his majesty's sister, and a plate from a picture which Vandyke painted to supply the place of that one of Titian's Cæsars which by some accident had been lost or destroyed: so that Voerft's title was not merely nominal. He engraved also from Vandyke, the portraits of Charles I. and his queen; (from the same celebrated picture which has been subsequently engraved by Vertue) that of the queen alone; sir Kenelm Digby, Inigo Jones, and several others, of which a list may be seen in lord Orford's catalogue. He handled his graver in a bold, free, and commanding style.

The style of Vorsterman exhibits more careful finishing and painter-like feeling, and must on the whole be allowed to be superior to that of his rival. He was to Rubens and Vandyke in England, and the Low Countries, what Marc Antonio was to Raphael in Italy. He may be said at once to have successfully translated and stereotyped the great originals of those very distinguished painters.

Mr. Strutt says of him with great truth that no one ever engraved more successfully from the pictures of Rubens: than whom, no painter that ever lived had the pleasure of seeing so great a number of his pictures finely engraved.

Vorsterman drew the human figure with correctness and taste. He was master of the graver, and could handle it with the utmost facility; but he paid much greater attention to the general effect of his prints, than to the regularity of the strokes; and like Gerard Audran, wished to enter into the thoughts of the master, and transcribe on copper the very life and spirit of his pictures, rather than shew his own dexterity in the mere mechanical part of the workmanship. The heads of his figures are finely drawn, and the extremities marked in a very masterly manner. Vertue mentions with approbation two drawings by Vorsterman, namely, a portrait of prince Henry, and a woman's head, after Leonardo da Vinci.

This celebrated engraver was a native of Antwerp, but from whom, or whether from any master, he learned the principles of painting and engraving, does not appear. He came over into England about the year 1623, and was occasionally employed both by king Charles I. and the earl of Arundel. His engravings are numerous, and chiefly from Rubens, Vandyke, and Holbein. Among those which may be mentioned with distinction are; from the former master, "The fall of the Damned," (a large upright); "The battle of the Amazons," a large and grand plate, printed on six sheets; "Lot leaving Sodom;" "The temptation of Job;" "Susanna and the Elders," and several others, particularly the "Return from Egypt," which he has treated in a manner differing from his usual style, and more bold and open. From Vandyke he has engraved a dead Christ, supported on the lap of the Virgin, and a considerable number of admirable portraits, among which are those of Charles I. and Vandyke himself; and from Holbein, he has engraved "Thomas duke of Norfolk," with the staves of lord treasurer, and earl Marshal, "Erasmus, sir Thomas More," and the painter himself. Sir Thomas has here a flatter face and smaller bonnet than in other pictures of him; and from the circumstance of Holbein's pencil being placed in his left hand, may be inferred, not that this print was a copy from another without being reversed on the copper (as lord Orford has surmised) but that Holbein painted with his left hand: a truth which the painter here meant to say of himself, and which the engraver has faithfully reported.

Nor must the illustrious name of sir Anthony Vandyke be omitted, in enumerating those of the artists who contributed to accelerate the progress of British engraving. The portraits which he etched of Snyders, Vorsterman, Paul Pontius, and other distinguished artists who were his contemporaries and friends, excited the just surprise and emulation of the painters and engravers of that age, and the best of them have continued to the present to be examples of excellence. Among the best may be reckoned that head of himself, looking over his shoulder, where he has introduced the golden chain which he had the honour of receiving, together with his majesty's picture in miniature, at the hands of Charles I. a circumstance which serves to shew that he etched this plate at least, and presumptively others, after his arrival in England. In some of those which he had previously executed, we see him contending, as it were, against the difficulties of his own imperfect knowledge of the newly acquired art, and that his plates are accordingly blurred with accidental scratches, and blotted and stained with foul biting, which all the skill of Bolswert, Neefs, and Vorsterman, who severally employed the graver in finishing most of his draperies and some of his faces, has not been sufficient to obliterate or conceal. His style of etching is original, vigorous, free, and expressive, and in some instances he has finished his heads with considerable care. The transcendental

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taste and judgment which he has so amply displayed in his pictures, guided and determined his hand in etching, and though nearly two centuries, which have boasted of their refinements, have elapsed since the period of their production, his "Ecce Homo" and his portraits, still preserve their stations in the collections of the tasteful, and are still esteemed among the most highly valued studies both of the portrait painter and engraver. By liberating British portrait engraving from the stiff regularity of the graving tool, which had before been too much regarded as a test of merit, Vandyke extended the views of the tasteful, while he taught the true value of outline, and light and shade.

It would not now be easy to ascertain the precise time when that important branch of engraving, which is technically termed *etching*, (for an explanation of its process, see the article *ETCHING*,) was introduced into England. Ortelius's and Bruin's publications contain some prints where etching appears to be mingled with the work of the graver, but if they are by English artists, those artists probably acquired their knowledge of etching in Flanders, where they practised it; and on the whole it seems highly probable, that no etching was performed in England till the period of Vandyke's and Hollar's residence in London, and that the honour of having introduced it belongs to one or the other of these distinguished characters. Vandyke was here and in high favour at the court of Charles I. when Hollar arrived, but whether he had then performed any of his admirable etchings is no where recorded; and as they are without dates, cannot now be easily ascertained. As neither of these distinguished men was the discoverer of an art, though each was the inventor of a style, it may be enough to believe it highly probable, that Vandyke was the first person who etched portraits in England, and Hollar the first who etched landscape and natural history.

It is not certain, that William James Delft, or *Van Delft*, (for he was so named from the place of his nativity,) was ever in England. Yet from his styling himself the king of England's engraver, and engraving portraits of Charles I., his queen Henriette Maria, and the duke of Buckingham, it should seem to be not improbable that he succeeded Voerft. Strutt says of him, that "he drew and painted portraits with great taste, and in a style that acquired him considerable reputation; but as an engraver of portraits he is more generally known, and in that light only I shall consider him. He worked entirely with the graver, and handled that instrument with the greatest facility. He drew correctly, and his best prints are very finely finished. Considering the great number of plates which were completed by the graver of this artist, it is not reasonable to suppose they should be all alike or equal in merit. Accordingly I shall distinguish two manners in which he engraved, and produced many excellent plates in both: first, a bold, powerful open style, productive of a fine effect; and as a specimen of it I would refer the reader to the portrait of Hugo Grotius, dated 1652: secondly, a neat and much more finished manner, as we find in the admirable portrait of Michael Miravelt (a near relation to the engraver,) from a picture of Vandyke." From the pictures of Michael and John Miravelt, he engraved a considerable number of portraits.

Wenceslaus Hollar, who has been already named, if not the first person who practised the art of etching in England, was the first who particularly distinguished himself in etching landscape, shipping, antiquities, and natural history.

This distinguished artist, a gentleman by birth, was a native of Prague in Bohemia, and intended by his parents to have been educated to the study of the law; but the civil commotions which happened in his youth, and which

led to the memorable battle of Prague, obliging them to abandon this intention, and his genius for art discovering itself about the same time, he was placed under Marian, an able designer and engraver of views, and by the time he had attained the age of nineteen, Hollar produced two plates, of which the subjects were an *Ecce Homo* and a *Madonna*, and child, (the latter from Albert Durer,) which drew forth the notice of the public, and confirmed the hopes of his friends. In the course of the next year (1636,) he engraved another of Albert Durer's *Madonnas*, and a plate which the superstitious might regard as ominous of his future fate, of "Fortune surmounting a Globe," which was also from Albert Durer.

He soon afterwards excelled in drawing geometrical and perspective views and plans of buildings; ancient and modern churches and abbeys, cities and towns; landscapes; and various kinds of natural and artificial curiosities, some of which he executed with a pen in a very masterly and peculiar style. To this art of drawing with a pen, he subsequently added the use of water-colours, which he occasionally, in the treatment of such subjects, as butterflies, beetles, &c. heightened and enriched with gilding in a very beautiful manner, as the volume of his drawings now in the possession of John Townley, esq. F. R. S. and F. A. S. of Park street, Westminster, abundantly testifies.

After passing some years in travelling through Germany, during which he drew and engraved views of Frankfort, Wurtzburg, Cologne, and other of its principal cities; but where he met with little encouragement: the earl of Arundel, then on an embassy to the Imperial court, met with him at Cologne, and being struck with his uncommon abilities, and particularly delighted with a large drawing of Prague, which Vertue says, "was curiously and exactly done with the pen and pencil," took him under his protection, and Hollar travelled in the ambassador's suite, from Cologne to Mentz, Prague, Nuremberg, Augsburg, Wurtzburg, Frankfort, Regensburg, Vienna, and finally to England, where it is said the noble earl recommended him to the favour of king Charles I.

There is some reason to fear that lord Arundel's patronage of Hollar was more nominal than real; and that the vanity of the patron was more gratified, than the fortune of the artist was promoted, by their connection. That Hollar was left destitute by the death of this nobleman, notwithstanding that political, were then added to his professional, merits, (for he was a zealous adherent to the cause of royalty and lord Arundel,) is freely excused on the ground of his lordship's own reverse of fortune, but it appears to imply more neglect than the liberal would else be disposed to impute to this nobleman, that during the first year of Hollar's arrival in England he was under the necessity of drawing and etching his view of Greenwich, which is more than two feet in length, for the paltry sum of thirty shillings! Yet the reader must wish in vain for a more honourable contrast between the parsimony of Stent, who purchased a *commodity* of Greenwich, with no other view than to enrich himself by the profits it might produce; and the liberality of the exalted peer, who deserved his exaltation as the patron and protector of talent, alive to the charms of art, and kindling with the flame of contemporary genius.

But it must be candidly allowed that the art of Hollar had little affinity with that of Vandyke, and, so dependent is the judgment in fine art of some men, upon the opinions of others, that the merit which lord Arundel thought he had discovered at Cologne or at Prague, might have faded in his own estimation when he approached the light of the court of London. Notwithstanding his own partiality and native

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native feeling for the merits of Hollar, Vertue is obliged to confess of him that "it is certain he could not so well enter into that master's (Vandyke's) true manner of drawing in his grace and touches, as other engravers, some in England and others abroad, who had studied his way or manner of drawing and painting; for which reason "he could not obtain Vandyke's recommendation, nor that of his admirers." Portrait painting was then the reigning fashion in England, and as the national taste for art was basking in the meridian splendour of the powers of Vandyke, it is not surprising that the less fortunate and more humble claims of Hollar were little seen, and met with small comparative encouragement.

Though the warmth of lord Arundel's patronage might perhaps be damped by these causes, he continued in some degree to befriend our artist. On his arrival in London, Hollar sat down with his habitual industry to engraving, and after producing his large plate of Greenwich, which shewed what he could do in this department of engraving, put aside for a time his talents for landscape and natural history, in order to accommodate himself to the public occasions and the prevailing taste, and soon completed an equestrian portrait of his patron, with two plates of king Richard II. kneeling before his patron saints, from an ancient altar folding table, and some other works from the Arundelian collection, including the curious cup which was designed by Andrea Mantegna.

In the year 1641, which was the year of Vandyke's decease, he engraved some portraits, including those of the king and queen, from the pictures of that celebrated painter. He had now been introduced to teach drawing to some branch of the royal family. Vertue thinks it was to teach prince Charles, having "seen a book mounting the arms or badge of the prince of Wales, (the crown and feathers,) wherein were drawings of parts of faces, &c. to begin to learn from, with some of Hollar's hand-writing;" but in an inscription under his portrait, published at Antwerp in 1648, and which inscription is supposed to have been supplied by himself, he says, he "had been domestic servant to the duke of York."

However this may have been, the civil wars which broke out soon after this mastership or servitude, tossed Hollar about with the royal party, ruined his better hopes, and obliged lord Arundel to return into Flanders. The engraver being left behind, resolved to try the fortune of war, and entering the army under the command of the marquis of Winchester, was made prisoner at Basing-house, in Hampshire, from which having, with some difficulty, effected his escape, he went over to Antwerp, in the year 1645, and once more sought the patronage or consolation of the earl of Arundel. He remained in that city for some years, endeavouring, through means of his art, to retrieve his shattered circumstances; but his patron going to Italy for the benefit of his health, and dying at Padua in 1646, Hollar was left to the accidents of precarious encouragement and the avarice of trade. He fell again into distress, and was obliged to work for the book and print-sellers at very low prices.

Under such circumstances were produced his book of heads, after da Vinci; his thirty-eight plates of shells, with many other subjects from the Arundelian collection; a considerable number of landscapes after Breughel, Elsheimer, Teniers, and other masters, and a still greater number of portraits, among which were those of Charles I., Charles II. when a youth, after Vandyke, the duke of York, after Teniers, which is now become very scarce, and his own portrait, after Meyfens. At the period of the restoration Hollar re-

turned to England, where, though he found sufficient employment to occupy his time, the prices he received for his engravings were so very inadequate to the labour which they necessarily required, that he could but barely subsist; and the plague putting for some time an effectual stop to business, and being soon after succeeded by the fire of London, the pecuniary embarrassments of our artist were greater than ever, of which Leake, Jennings, Mark, and those other dealers, for whom, in the course of the years 1666 and 67, he engraved various views and plans of London, before and after the great fire, did not fail to take advantage.

"Born to misfortune as the sparks fly upwards," it was soon the fate of Hollar to turn his hopes once more toward the court, for that protection and encouragement which commerce blindly refused him; and in the years 1668 and 69 he was employed by government under the orders of lord Howard, to make drawings of the town and forts of Tangiers, which he afterwards engraved. In this perilous service, he narrowly escaped being killed or made prisoner by the Turks. The ship, on board which he had embarked for England, the *Mary Rose*, Capt. Kempthorn, fought seven Algerine Corsairs off Cadiz, and had eleven men killed and seventeen wounded; but Hollar escaped unhurt, and had afterwards the honour of engraving a plate of the battle.

On his return to England, he received no more for the difficulties and dangers which he had encountered, the drawings he had made, and the year he had spent in this arduous service, than one hundred pounds; and this, according to Vertue, was not obtained till after long attendance at the public offices, and experiencing many of those rebuffs "which patient merit from the unworthy takes."

From this time till the year 1677, when death put a final period to his exertions, he spent much of his time in travelling through the northern counties of England, and delineating and engraving their topography, and produced those plates which are now objects of so great curiosity, and will be yet more highly valued by posterity, as shewing what England was (and what Hollar was) during the reign of Charles II. The plates for Thoroton's Nottinghamshire and Sandford's Genealogical History, were engraved in the course of the three last years of his life.

He used to work for the mercenary book and print-sellers at the rate of fourpence an hour, always having an hour-glass before him; and was so scrupulously exact, that when obliged to attend the calls of nature, or whilst talking, (though with the persons for whom he was working, and about their own business,) he constantly laid the glass on its side, to prevent the sand from running. Yet notwithstanding his exemplary industry, and this rigid adherence to principle; notwithstanding his extraordinary merit as an artist; notwithstanding his loyalty and the past favour of lord Arundel and Charles I., Hollar died poor and miserable, after a life of vicissitude, and for the most part of suffering.

During the dissolute reign of the second Charles, who was to listen to the claims of modest and retired merit? The delighted purchasers of his "*Seleucus*," after Julio Romano; his "*Fountain of Pleasures*," or his "*Queen Sheba visiting Solomon*," (as will be the case under any reign where *patrons* are content to be acquainted with contemporary art only through the medium of parasites and dealers,) were either heedless of what befel their author, or were deceived into the belief that he was at least comfortably provided for; and while Stent, Overton, Green, and the rest of the dealers of that day, enjoyed their fire-sides in comfort, or rioted in the lap of luxury, on the profits of his works, the engraver of more than two thousand plates, which are since sought for through Europe, and most of which

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which are after his own designs, expired in the very act of intreating the bailiffs, who had entered his wretched apartment, for a little forbearance.

Hollar's plates are for the most part etchings, touched here and there, where superior clearness was wanted, or the aquafortis had not accomplished its purpose, with the graver. His small plates are superior to his larger; his style of handling his etching-needle is pleasing, and was original; and, in the accuracy, freedom, lightness, spirit, and finish of his cities, abbeys, cathedrals, and some other of his landscapes, and his plates of natural history and still life, he much excelled his contemporaries; even those on the continent: but in drawing the human figure he was not equally well informed, and his hands and feet are therefore often defective.

In conformity with the false preference which fashion had conferred on works performed solely with the graving-tool, he attempted to execute some plates with the graver only, but has here failed of the success that attended him in etching.

Hollar appears to have been a meek-tempered man, and to have wanted the necessary confidence in his own powers or the public taste, to venture on publishing any of his own engravings; though Vertue ascribes this effect to a different cause, which, no doubt, was at least a concomitant, he says, "I don't find that at any time he worked for himself, to sell or publish, as has been customary with professors of that art (engraving) when they had substance of their own, or friends and interest sufficient." Alas! what is society if it befriend not the ingenious.

The innate love of engraving must be strong in some minds, or the necessity of practising that art must be imperious, for Hollar to have left successors. The truth, however, is, that in the department of his art, in which Hollar's merit chiefly resided, he had no successor, for Barlow, of whom we shall presently speak, was an English painter, who merely learned of him the process of laying etching-grounds and using aquafortis; and William Carter, Daniel King, and Thomas Dudley, who were all natives of England, and pupils of Hollar, rather followed him to the grave, than succeeded him in art. The former was used occasionally to assist his master; imitated feebly his style of etching; and is the engraver of the vignette head-pieces to Ogilby's Homer, and probably of many other of those anonymous book-plates that some collectors ascribe to Hollar. King is somewhat more conspicuous. He published "The Vale Royal of Cheshire" from his own drawings; and engraved for Dugdale's Monasticon, and some other plates of topographical subjects. Dudley has occasionally subscribed himself "quondam condiscipulus W. Hollar," and Mr. Strutt's account of him is as follows. "He was a native of England, and one of the pupils of the famous Hollar, whose manner of engraving he imitated. But though he never equalled his master in the lightness of his point or freedom of execution, his etchings are not without merit. His most considerable work was a set of cuts for the life of Æsop, prefixed to the last edition of his Fables, published by Barlow. He also etched the portrait of bishop Ruffel, which is subscribed Thomas Dudley Anglus fecit 1679."

R. Gaywood has also been mentioned as a disciple of Hollar, but he etched no views, or other landscapes, and in engraving portraits employed less of etching; and, in short, did not confine himself to the style of that master, but blended with it what he acquired from studying Vorst, Vorsterman, and the other engravers of the Vandyke school.

Gaywood engraved a considerable number of portraits, among which are those of queen Mary of Scotland, with a cross; the countess of Portland, Holbein, Vandyke, and Dr. Faustus. The only historical engraving of any conse-

quence from his hand is the couchant Venus of Titian, which was once in king Charles's collection, and since in that of the earl of Cholmondeley.

Of Francis Barlow much more may with the greatest truth be asserted. This artist was a native of Lincolnshire, but in what year he was born was not known. He received his first instructions in art from a portrait painter of final note of the name of Shepherd, and if he learned the use of the engraver's instruments from Hollar, he formed a style for himself.

The inventive powers of Barlow were extremely fertile. His great merit lay in designing and etching quadrupeds, birds, fishes, insects; in short, the whole volume of animated nature appears to have been open to his view, and in this respect, he is the fittest of all men to be the companion of that great moral philosopher Æsop, whose fables he has so admirably embellished. His human figures, which with considerable judgment, he occasionally introduced, exhibit the dresses and manners of his age; he had observed the natural instincts and customs of animals, and has delineated them with a fidelity which is surprising; and his landscape backgrounds often assume a grandeur which could only result from elevated ideas of art.

His compositions shew that he had studied the animal and landscape painters who preceded him, as well as nature herself, with advantage. In forming his style of etching, he has evidently looked at the animals of Hollar, yet is original, vigorous, free, and so happily varied, as to express the feathery and hairy surfaces of birds and quadrupeds with a degree of success which none of his predecessors, and only Hollar among his contemporaries, will bear to be compared with.

The frontispiece to his Æsop's fables, where Æsop himself appears surrounded by animals; the angler and entreating fish, with its landscape accompaniments; the prostrate camel; the battle of the frogs and mice; and the oak, and reed bending before the storm, may be mentioned with distinguished praise. His foxes, camels, asses, and wolves, are in general most excellent, and all his birds are so, without exception: but his lions, wherever they occur, are either ideal lions, and not well conceived, or shew that he had once seen and drawn from a bad model, and repeated it wherever he had occasion for a lion.

Part of "Monk's funeral" is Barlow's engraving: and several of the plates for Edward Benlowe's "Theophrastus," published in folio, A. D. 1652; and some of those for Ogilby's Virgil, are also designed and etched by Barlow.

That at some period of his life he had travelled northward, may be seen in the print which F. Place has engraved after his drawing of "the Bass Island," wherein he has introduced soland geese, curlews, gulls, and all the varieties of Northern sea fowl; and if he sailed thither from any port of Scotland, it was probably during this journey that he saw in the latter country an eagle soaring with a cat in its talons, of which he afterward engraved a spirited plate. This anecdote is recorded both by lord Orford and Mr. Strutt, who agree in stating that Barlow witnessed this contention in the air whilst he was drawing a view in Scotland, and that the cat's resistance had the effect of bringing both animals to the ground.

At one period of his life, probably towards its close, he resided near the sign of the Drum in Drury-lane. That he was industrious is attested in the great number of his productions; yet notwithstanding this circumstance, and the praise of superior excellence to which he is so justly entitled: and notwithstanding the assistance of (Mr. Strutt says) "a considerable sum of money," (he does not say how much) which was

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left him by a friend, he died in indigent circumstances in the year 1702.

Francis Place has sometimes been spoken of as if he had learned etching of Hollar, but in a letter to Mr. Vertue he denies this; and indeed the style which he adopted and the number of plates which he has engraved after the drawings and pictures of Barlow, teaches us rather to think he must have studied under that master, if under any master at all. Lord Orford says "his prints are very scarce," but in a book which contains "sixty-seven excellent and useful prints of birds and beasts" after Barlow, to which modern students and even academicians are not a little indebted, and worn impressions of which book may now be purchased of Carington Bowles for half a guinea the set, are twenty plates of a moderate size, which bear the name of Place, beside others which on a critical inspection may be seen to be from the same hand. The birds in these prints are etched with so much of the spirit and feeling of Barlow himself, that they might well be suspected to be his own performance, but for the name of Francis Place, which is annexed; nor are his grassy foregrounds, and the foliage and ramifications of his trees less excellent.

"This ingenious artist was the son of Mr. Rowland Place, of Dinsdale, in the county of Durham." When young he was articled as clerk to an attorney in London, where he continued till the year 1665, when certain officers coming to shut up the house where he resided, on account of the plague, he took the opportunity of quitting a profession that did not accord with his inclination, "and of following (says lord Orford) the roving life he loved, and the arts for which he had talents."

In the course of his various rambles, he drew, painted, and engraved, as inclination prompted or opportunity occurred, besides discovering some occasional disposition to mineralogical research, and skill in the manufacture of pottery.

He drew and engraved views of Tintmouth castle and light house, the cathedral of York; Scarborough castle, several plates for Thoresby's Topography of Leeds, beside various other views in England, Wales, Scotland, and Ireland, and the figures for Godartius's book of insects.

His former biographers agree in affirming that during the reign of Charles II. he was offered a pension of 500*l.* per annum, to draw the royal navy, but declined accepting it, having a competence without, and from his natural love of independence and dislike of confinement. He died in the manor house of York in the year 1728.

Beside the etchings which are here enumerated, and several others, Place engraved the portraits of bishop Crewe, general Lambert, and Richard Thompson, in mezzotinto: to treat of the discovery and introduction of which art, we must return back a few years.

Mr. Evelyn has been justly ridiculed by lord Orford, for the mysterious and paradoxical manner in which he announces prince Rupert's discovery of mezzotinto. It is, perhaps, one of the most honest, most candid, and most happily expressed, of the numerous pages which his lordship has written on the subject of fine art. "Ancient sages, says he, used to wrap up their doctrines, discoveries or nonsense, in such unintelligible jargon: (as Mr. Evelyn's) and the baby world, who preferred being imposed upon to being taught, thought themselves extremely obliged for being told any secret which they could not comprehend. They would be reckoned mountebanks in this age, who should pretend to instruct without informing; and one cannot help wondering that so beneficent a nature as Mr. Evelyn's should juggle with mankind, when the inventor himself had consented that the new art should be made public.

"It is a trite observation that gunpowder was discovered by a monk, and printing by a soldier. It is an additional honour to the latter profession to have invented mezzotinto. Few royal names appear at the head of discoveries; nor is it surprising. One cannot expect that many of the least common rank should be blessed with uncommon abilities. Quickness to seize and sagacity to apply are requisite to fortuitous discoveries. Gunpowder, or printing, might have fallen in many a prince's way, and the world have been still happy or unhappy enough not to possess those arts. Born with the taste of an uncle whom his sword was not fortunate in defending, prince Rupert was fond of those sciences which soften and adorn a hero's private hours, and knew how to mix them with his minutes of amusement without dedicating his life to these pursuits; (like us, who, wanting capacity for momentous views, make serious study of what is only the transitory occupation of a genius.) Had the court of the first Charles been peaceful, how agreeably had the prince's congenial propensity flattered and confirmed the inclination of his uncle! How the muse of art would have repaid the patronage of the monarch, when for his first artist she would have presented him with his nephew! How different a figure did the same prince make in a reign of dissimilar complexion! The philosophic warrior, who could relax himself into the ornament of a refined court, was thought a savage mechanic, when courtiers were only voluptuous wits. Yet if the prince was defective in the transient varnish of a court, he at least was adorned by the arts with that polish which alone can make a court attract the attention of subsequent ages.

"Going out early one morning during his retirement at Brussels, he observed the sentinel at some distance from his post, very busy doing something to his piece. The prince asked the soldier what he was about? he replied, the dew had fallen in the night, had made his fusil rusty, and that he was scraping and cleaning it. The prince looking at it, was struck with something like a figure eaten into the barrel, with innumerable little holes closed together like friezed work on gold or silver, part of which the fellow had scraped away.

"The *genie second en experiences*, from so trifling an accident conceived mezzotinto. The prince concluded that some contrivance might be found to cover a brass plate with such a grained ground of fine pressed holes, which would undoubtedly give an impression all black; and that by scraping away proper parts, the smooth superficies would leave the rest of the paper white."

Communicating his idea to Wallerant Vaillant, a reputable painter then in the neighbourhood of Brussels, they made several experiments, and at last invented a steel roller with projecting points or teeth like a file, which effectually produced the black ground, and which being scraped away, or diminished at pleasure, left the gradations of light.

Such was the invention of mezzotinto according to lord Orford, Mr. Evelyn, and Mr. Vertue; but the baron Heinekin affirms that "it was not prince Rupert who invented the art of engraving in mezzotinto, as Vertue and several other authors pretend to say; but it was the lieutenant colonel de Siegen, an officer in the service of the landgrave of Hesse, who first engraved in this manner; and the print which he produced was a portrait of the princess Amelia Elizabeth of Hesse, engraved as early as the year 1643. Prince Rupert, he adds, learned the secret from this gentleman, and brought it into England when he came over the second time with Charles II."

The present writer has not seen the print thus spoken  
of

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of by the baron: and the precise date of prince Rupert's discovery is no where mentioned. But if a mezzotinto engraving dated seventeen years before the restoration can be produced, and the date be genuine, it certainly goes far toward proving Heinnekin's assertion. Vertue acknowledges to have seen an oval head of Leopold William, archduke of Austria, in mezzotinto, that was dated in 1656, which he esteems the earliest. It is inscribed "Theodorus Casparus à Furstenburgh canonicus ad vivum pinxit et fecit;" but this argues little against prince Rupert's discovery, since it is quite within probability that Casparus might have learned the art from the prince or Vaillant during their residence in the Low Countries.

The earliest of Rupert's engravings in mezzotinto, that is now extant, is dated in 1658. It is an half length figure from Spagnoletto: the subject, an executioner holding a sword in one hand and in the other a head, which is probably intended for that of John the Baptist, and upon the sword are the initials R. P. F. surmounted with a coronet. It is further distinguished by the following inscription on a tablet beneath "SP in RVP. P. fecit. Francofurti. anno 1658 M. A. P. M."

Return we now to the historical progress of English engraving, properly so called; referring to the word *MEZZOTINTO*, for the improved modern process of that branch of the art.

Lord Orford speaks of William Faithorne the elder with distinguished praise, and has given a tolerably correct list of his engravings, which he has separated into five classes, and to which the reader, who may wish to arrange the works of Faithorne, is referred. He lived at the same period with Hollar, and about the year 1654 in the very same house; but the year of his birth has not been ascertained. He was the disciple of Peak, the painter and print-seller, who was afterwards knighted, for whom he worked three or four years. With Peak he espoused the royal cause, when the civil wars broke out between king Charles and his parliament; and with him, and probably with Hollar also, was taken prisoner at Basing-house; from whence he was sent to London, and confined for some time in the prison of Aldersgate. In this uncomfortable situation he exercised his skill as an engraver; and here he produced a small head of the first Villiers duke of Buckingham, which is in the circular style of Mellan.

At the solicitation of his friends, he was released from confinement, and permitted to retire to France: though Graham says, he was banished for refusing to take the oaths of allegiance to Cromwell, and that he studied several years under Champagne.

Vertue, who received his accounts of Faithorne from Mr. W. Hill Clark, and Mr. Bagford, lord Orford's librarian, seems to discredit these facts; but all agree that he found protection and encouragement in France from the abbe de Marolles, and obtained improvement under the justly celebrated Nanteuil.

The latter indeed is sufficiently obvious in his engravings. At his return to England, which lord Orford thinks was before the time of the protectorate, he married a sister of captain Croud, by whom he had two sons, and opened a print-shop opposite the Palsgrave-head tavern, without Temple-bar, assuming the sign of the Ship. Here he not only followed his art, but sold Italian, French, and Dutch prints, and also the engravings of other English artists; some of which are still to be seen with the subscription "sold by William Faithorne." And here he appears to have remained about 30 years.

"Some time after the year 1680," says lord Orford,

"Faithorne quitted his shop, and retired to a more private life in Printing-house yard, Blackfriars; still engraving, but chiefly painting from the life in crayons, in which art he had formerly received instructions at Paris from Nanteuil." He also painted miniatures, and drew portraits in black and white. Faithorne was a robust and vigorous man; but the misconduct and consequent misfortunes of his son William, broke down his frame and spirits, and he died in the year 1691, and was interred in the church of St. Anne, Blackfriars.

The principal part of his engravings appears to have been executed during his residence near Temple-bar, where he also wrote and published a "Treatise on Engraving," A.D. 1662, which he dedicated to his former master, sir Robert Peake. The contents of this book, as displayed in the title page, are as follows: "The Art of Graving and Etching, wherein is expressed the true way of graving on Copper; also, the Manner and Method of that famous Callot and Mr. Bos, in their several ways of Etching."

Portraits constitute by far the most numerous part of this artist's works. He worked almost entirely with the graver, in a free and clear style, paying more attention to the beauty of his lines than most of his British predecessors. In the early part of his life, he seems to have followed the Dutch and Flemish manner of engraving; but on his return from France, his improvement was evidently considerable. His portraits are his best works; and the best of his portraits are justly admired for their delicacy, freedom, and force of chiaro-scuro.

Mr. Strutt has distinguished the following among the more valuable of Faithorne's historical engravings: "a holy Family," from S. Vouet, a middling sized plate, in the style of Couvy; "a dead Christ," from Vandyke; "the last Supper," without any painter's name, in folio; "Christ praying in the Garden," the same; "the Marriage of Cana in Galilee," an etching, the same; "the Scourging of Christ," from Deepenbeck. Under this latter print is written "Faithorne Sculp. Antwerp, 1657," which date seems to have escaped the notice of Vertue, and to falsify the opinion that lord Orford, on his authority, had formed, that "Faithorne returned to England before the protectorate."

His portraits, as has been already intimated, are too numerous to be detailed in this place.

William Faithorne the younger was far inferior to his father as an artist. His principal works are portraits, scraped in mezzotinto, of which Vertue has particularized about thirty, with three prints of fancy subjects, and a head of St. Mary Magdalen.

John Fillian was also a disciple of the elder Faithorne, whose style and some of whose portraits he copied. He was living in 1656, but died at an early age. His principal works are, "a Head of his Master," looking over his shoulder, which is copied from a print by Faithorne himself; the portraits of "Thomas Cromwell," and "Paracelsus," and the "Frontispiece" to Heylyn's Cosmography, in folio.

Of Peter Lombart, Vertue has been able to trace little, but that he came from Paris, and returned thither after remaining for some years in England; to which Strutt adds, that he was a native of France, and came into England before the revolution.

He worked in a neat, laboured style, and discovers but little taste. His drawing is frequently incorrect; his outlines hard; his shadows deficient in force and boldness; his lights of too low a tone, and even his engravings after Vandyke are deficient in force, though he has discovered a

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tolerable eye for the *harmony*, of *chiaro-scuro*. Yet he worked after the pictures of the greatest masters: after Raphael, Guido, Poussin, Annibal Carracci, and Vandyke. Among the best of his engravings are, "the last Supper," a large upright, from Nicholas Poussin; "the Angel appearing to Joseph," after Ph. Champagne; "the Crucifixion," from the same master; the "Frontispiece," and several other plates for Ogilby's Virgil. Among his portraits from Vandyke is that of "Charles I." on horseback, a large half-sheet print. From this plate he afterwards erased the face, and substituted that of "Cromwell;" and at a subsequent period, "with the vicar of Bray's graver," as lord Orford wittily says, restored the king's.

Vertue has enumerated twenty other of his portraits, which are chiefly after the same master; and to them may be added a set of twelve half-lengths of rather a large size, of which ten are portraits of celebrated ladies of the court of king Charles.

Notwithstanding his reserve in communicating prince Rupert's discovery of mezzotinto, John Evelyn, esq. of Wootton, in Surrey, is entitled to honourable mention in this place. He was the first English gentleman who wrote upon the subject of engraving; and though his "Sculptura" be deficient in artificial knowledge and feeling, it is a work of considerable erudition, and has contributed not a little to the advancement of the art; while it clearly evinces his love for engraving, the excellence of the example which he wished to set, and the general goodness of his heart. Lord Orford handfomely says of him: "If Mr. Evelyn had not been an artist himself, as I think I can prove [that he was], I should yet have found it difficult to deny myself the pleasure of allotting him a place among the arts he loved, promoted, patronized; and it will be but justice to inscribe his name with due panegyric in these records, as I have once or twice taken upon me to criticize him: but they are trifling blemishes, when compared with his amiable virtues and beneficence; and it may be remarked, that the worst I have said of him is, that he knew more than he always communicated."

The duration of the life of this great contributor to learning and the arts was protracted to 86 years, and he died in 1705.

It appears now to be agreed among the connoisseurs, that the five small prints of Mr. Evelyn's "Journey from Naples to Rome," which his biographer thought were etched by Mr. Hoare, are Evelyn's own performances; and to these Mr. Strutt has added a "Portrait of Dobson" the painter, from a picture by himself.

David Loggan was a native of Dantzick; he was born about the year 1635, and died in 1693. From Simon Pass, in Denmark, he is said to have received his earliest instructions in engraving; he afterwards resided in Holland, where he studied under Hondius; and a short time before the restoration he came to England.

His drawings of All-Soul's college being taken great notice of at Oxford, he was requested to undertake plates of the public buildings in that university. By these engravings he first distinguished himself; and at Oxford he remained a considerable time, and married Mrs. Jordan of a good family, near Witney. In the latter part of his life he resided in Leicester fields, London; where he died.

In satirising the vanity of a certain dramatic poet, Dryden says,

"And in the front of all his senseless plays,  
Makes David Loggan crown his head with bays."

Yet as Loggan's merits as an engraver were not such as to

crown his own with lasting reputation: his *name* will probably live much longer than his works will be cared for. He etched very little, and his style of engraving, though it has a certain degree of neatness, is stiff and tasteless. His portraits, of which he executed a considerable number, are chiefly after his own drawings in black lead, which he handled with more ability, at least with a better taste, than his graver.

Vertue has enumerated 76 portraits from the hand of Loggan, of which the principal are, three plates of "Charles II.;" "Mother Louisa of Louisa-hall," which it seems added much to his contemporary reputation; and "George duke of Albemarle," a half-sheet print, and probably his best portrait from the life. He also engraved two views of "Cambridge;" a whole sheet view of "King's College Chapel" in that university; several views of public Buildings at Oxford; and eleven plates of the "Habits of the Academics" at that university, which are entitled, "Habitus Academicorum Oxoniæ a Doctore ad Servientem;" and had (what seems an odd thing) a licence for fifteen years for vending his "Oxonia Illustrata."

With David Loggan came over from Holland Abraham Blooteling and Gerard Valek, men of superior talents, though probably of inferior address. Vertue informs us, that whilst in England, Blooteling received thirty guineas (a large price in those days) for an etching of the duke of Norfolk. His powers were various: he etched, engraved, and scraped in mezzotinto. His etchings are spirited and free; and his mezzotintos of a clear grain, and tolerably well drawn. About eighteen of his portraits are enumerated by Vertue, of which the principal are, "Anthony earl of Shaftesbury," one of the scarcest of Blooteling's works; and "Prince Rupert," after sir P. Lely. The portrait of "Admiral Kortenaar," a large upright, from Bartholomew Vander Helst, is not among those mentioned by Vertue.

After remaining some few years in England, Blooteling returned to Amsterdam; and in the year 1685, published there the "Gems of Leonardo Augustino," from plates etched by himself.

Gerard Valek was originally Blooteling's servant, (perhaps apprentice,) but afterwards married his sister. Some of the best engravings, or best parts of those engravings, which were published in the name of Loggan, are probably the performances of Valek, who also assisted Peter Schenck in his large Dutch Atlas, published in 1683. Lord Orford says, that he "engraved one of the finest prints we have: it is the famous "Duchess of Mazarine," sitting in very loose attire, with one hand on an urn;" but this praise is more than the engraving deserves. His other works are, a "Bathsheba bathing," from B. Graat; and the portraits of "Robert Lord Brooke," and "John Duke of Lauderdale." Vertue knew of no other plates that were entirely engraved by Valek.

Notwithstanding the "Sculptura" of Evelyn, and the merits of Hollar, Barlow, Faithorne, and the engravers of the Vandyke school, the tastelessness and dissolute manners of the court of Charles II. had now reduced the art of engraving to a very low ebb. Its records are scarcely more than those of the commonest trade.

Edward le Davis was of Welsh extraction, and, having some inclination for the arts, was articleed as an apprentice to David Loggan. Being maltreated by his mistress, who obliged him to wear a livery, and follow her as a servant, he absented himself, went over to France, and became a dealer in pictures. On his return he drew and engraved several portraits, and some other subjects; but their merits are inconsiderable. Vertue mentions the names of nine of these portraits,

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portraits, of which the most remarkable are, "King Charles II." seated, whose face was afterwards erased from the copper, and that of William III. substituted in its stead; "Queen Catherine of England," a large whole length; and "James Duke of York," a large head in an oval, surrounded by flowers. Le Davis also engraved an "Ecce Homo," after Caracci, which is become scarce; and "a Merry Andrew," after Frank Hals.

About the same time with Blooteling, Michael Burghers was also driven hither by the troubles in the United Netherlands, and settled at Oxford. His works are executed entirely with the graver, in a stiff, laboured style: and his drawing of the human figure very defective. The most valuable of his engravings are the antiquities, consisting of ancient pavements, ruined monasteries, &c. which he executed for that indefatigable antiquary, Thomas Hearne. Mr. Strutt, speaking of them, says, "though we cannot admire the taste with which they are executed, yet they become estimable, because they still continue to us an idea of those monuments of antiquity, which time had otherwise obliterated for ever."

Excepting these, his best prints are probably a few which he copied from Mellan, wherein he imitated the spiral style of that singular master, and among which are, a large "Face of our Saviour," executed in a single spiral line; and "a Frontispiece" to Creech's translation of the Satires of Horace, a much smaller plate. He also engraved some few of the "Oxford Almanacks," beginning (though the plate appears without his name) in the year 1676, and did several other plates, among which are the old chapel of Queen's college, before it was pulled down, for that learned university; sometimes adding to his name, when he inscribed it beneath his engravings, "Academix Oxon. Calcographus."

Peter Vanderbank was an engraver of more merit. He was born at Paris, though probably of Dutch ancestors, and studied under De Poilly. He arrived in England about the year 1674, and here he married the sister of Mr. Forester of Bradfield, in Hertfordshire. Lord Orford says, he "was soon admired for the softness of his prints, and still more for the size of them; some of his heads being the largest that had yet appeared in England." But softness and admiration are comparative terms; and the reader must not suppose that his portraits are in that respect comparable with those of Nanteuil or Houbraken. Yet the merit of paying more attention than had hitherto been paid in England to the manual part of engraving is certainly his; and this circumstance, added to the large dimensions of many of his plates, occasioned them to occupy so much time, that he was by no means adequately compensated for his labour. After struggling for a time with poverty, print-dealers, and the low taste of the times, he retired without compromising his merits, and found an asylum under the friendly roof of his brother-in-law at Bradfield, where he died in the year 1697.

"After his death, his widow disposed of his plates to Brown, the print-seller, who made great advantage of them, and left an easy fortune."

Vanderbank engraved some plates after Verrio's pictures at Windsor, but by far the greater part of his works are portraits, of which Vertue has enumerated no fewer than fifty! which, considering the large size of some of them, is no trifling evidence of his professional diligence. Those of most importance are, "King Charles II." in his greater robes, after Gaspar, (done the year after Vanderbank's arrival;) another portrait of Charles, two feet four inches high, by two feet wide; "King James II." after sir Godfrey Kneller, large; "Mary

his Queen," ditto; separate plates of "King William" and "Queen Mary;" "Thomas Lamplugh, archbishop of York," which is one of the finest of his works; and two heads of Waller the poet, at the ages of twenty-three and seventy-six.

Arthur Soly, William Elder, John Drapentier, Robert Jackson, Francis Bragge, Paul Vanfomer, Nicholas Yates, John Collins, Simon Gribelin, William and John Clarke, and R. Tompson, who all lived and engraved about the time now under our observation, are unworthy of particular notice. "The art of engraving," says Vertue, "had sunk so low about the close of the century, that Verrio, Cooke, and Laguerre, could find no better artists to engrave their designs than Gribelin and Vanfomer." "He might in justice have added," observes lord Orford, "that the engravers were good enough for the painters."

Of Robert White, who was born in London in the year 1645, and died in 1704, little more can be said, except on the score of his drawings in black-lead, and his professional industry, which, judging from the number of his engravings, may well excite our surprize. Vertue praises his portraits more than they will be found to deserve as engravings. Yet all his biographers agree that the merit of producing a strong likeness was certainly his, and in portrait engraving this is the first of merits.

The president of the Royal Academy (Mr. West) is in possession of some of his pencil drawings on vellum, which are superior to his prints; and sir Godfrey Kneller thought so well of them, that he painted White's portrait in return for drawings of his own and his brother's, from the hand of the engraver. The reader will find White's portrait of sir Godfrey in Sandrart's lives of the painters.

From David Loggan he learned the rudiments of engraving, and in the year 1674, which is two years before Burghers was employed on the "Oxford Almanack," White produced the first of that series.

For the generality of his portraits for books, which are disfigured by the broad borders that were then the fashion, he received at the rate of four pounds each, with the occasional addition of ten shillings; thirty pounds, which was paid him by Mr. Sowters of Exeter for a portrait of the king of Sweden, (which the present writer has not seen, but which was probably of much larger dimensions,) has been spoken of as an extraordinary price. So great, however, is the number of his engravings, that in the course of forty years he saved from four to five thousand pounds; and yet, say his biographers, (with little reflection copying each other,) by some misfortune or sudden extravagance, he died in indigent circumstances at his house in Bloomsbury. The reader, probably, will not readily believe, that the habits acquired by the patient professional industry of forty years, could plunge into sudden extravagance.

Of his own works he made no regular collection, but when he had done a plate, rolled up two or three proofs, and flung them into a closet, where they were found in heaps. Many of these proofs may now be found in the collections of those curious persons who take Grainger for their guide.

The plates which he had by him were, after his decease, sold to a printseller in the Poultry, who in a few years, according to lord Orford and Mr. Strutt, enriched himself by the purchase. Vertue expresses his honest displeasure that so large a portion of the produce of our engraver's industry should devolve to the dealer; but so it has ever been: and if he complains for White, how loudly should he complain for Milton!

The number of his portraits of which Vertue has collected the names, are two hundred and seventy-five, of which,

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which, two are scraped in mezzotinto, and all the rest engraved in lines. Some few of Robert White's plates are finished by his son George, who chiefly practised in mezzotinto, but engraved a few plates in lines, of which the principal one is a large portrait of "James Gardiner," bishop of Lincoln.

John Sturt, the pupil of White, who was born in London in the year 1658, and lived to the age of seventy-two, was a man of ignorant ingenuity. His principal work is the "Book of Common Prayer," which he engraved on silver plates. The top of every page is ornamented with a small historical vignette. Prefixed is the bust of George I. in a circle, and facing it the prince and princess of Wales. The peculiarity of this work is, that the lines of the king's face are expressed by writing, so small that few persons can read it without a magnifying glass, and that this writing consists of the Lord's prayer, the Ten Commandments, prayers for the royal family, and the 21st Psalm. So that here are prayers which cannot be read, and a head which might have been better produced with a hundredth part of the labour. This uncommon Common Prayer Book was published by subscription in London in the year 1717. It was in large octavo, and was followed by a "Companion to the Altar" of the same size, and executed in the same manner. Sturt was also the first man who posed the wondering multitude of "microscopic wights," by engraving the Lord's Prayer within the area of a circle of the dimensions of a silver penny.

To this wonder-niggling state was engraving reduced, when, at the commencement of the new century, sir Nicholas Dorigny shone forth on the darkened arts of England. He was born in France, and was a younger son of Michael Dorigny, by a daughter of Vouet the painter. His father dying whilst he was young, he was brought up to the study of the law, which he pursued till he was about thirty years of age: being then examined, in order to his admission into the corps of advocates, the judge found him very difficult of hearing, and accordingly advised him to relinquish a profession for which he was in this respect so ill qualified by nature. He took the advice, and immediately applied himself to drawing with great assiduity. After a year's experience in this art he repaired to Rome, where his brother at that time resided, and here he followed painting for some years; when, having acquired great freedom of hand, and being uncommonly docile and flexible in his disposition, he followed the recommendation of certain friends, who advised him to study etching. In this art he produced several works of merit, but the engravings of Audran, which were now the topic of general and just encomium, convinced him that the style he had adopted was susceptible of great improvement; and he employed *ten years* in emulating the vigour and grandeur of that distinguished artist. He had now etched many plates, and among them the series from the fable of "Cupid and Psyche," after Raffaele, when, feeling that he had not acquired that command of the graver which was necessary to the harmonious perfection which he contemplated, he abandoned engraving for a short time and returned to his pencils. "A word from a friend," says lord Orford, "would have thrown him back to the law:" this, however, it is not easy to believe.

After two months re-application to painting, he resolved to acquire that power over the graver, of which he had so strongly felt or fancied the necessity. All these feelings and resolutions are those of an artist of genius. With a little instruction, he rapidly acquired the knowledge and power of which he was in quest, and begun to engrave the set of "Seven Planets," after Raffaele; in which he

succeeded so well, that he was now emboldened to undertake Raffaele's "Transfiguration," the accomplishment of which raised his reputation to an extraordinary height.

Being known to several English noblemen and gentlemen of rank, who at that time resided in Italy, he was persuaded to come to England, and undertake to engrave the Cartoons. He arrived in June 1711, but experienced some disappointment, and was not enabled to begin his drawings till the year following, the intervening time being spent in raising a fund to enable him to prosecute his intended work.

At first it was proposed that the plates should be engraved at queen Anne's expence, and that the impressions should be given as presents to the nobility, foreign princes, ministers, &c.; but this was too liberal even for what has been emphatically called the Augustan age of England, which had now commenced. Dorigny estimated the expences at four or five thousand pounds, but though the lord treasurer Orford exerted himself greatly in the cause of the artist, he could not obtain the sum, and this plan was consequently rendered abortive.

The engraver had, however, an apartment assigned him in Hampton Court palace, and the work was at last undertaken by a public subscription, at four guineas the set.

The labour of seven plates of the large dimensions that were resolved on, appearing too great for the hand of a single individual, who was not young, Dorigny was induced to send to Paris for assistance; and for the first two or three years obtained that of Dupuis and Dubosc, who both quitted him before the engravings from the Cartoons were half completed.

In somewhat less than seven years, however, from the date of his arrival, (namely, on the 1st day of April, 1719,) Dorigny had the honour of presenting two complete sets of these celebrated engravings (with an engraved dedication) to king George I., one set to the prince, and another to the princess, when he received from his majesty a purse of a hundred guineas, and a medal from the prince; and the duke of Devonshire, of whom he had borrowed four hundred pounds, freely remitted the interest for four years. His reputation from this time continued to increase through Europe, and in the year following, he received the further honour of knighthood from the hand of his majesty.

In a few years after the completion of the Cartoons, the eyes of our engraver began to grow dim, and either this circumstance; or the natural inclination of man to return to the place of his nativity, occasioned his return to Paris, where, in the year 1725, he was made a member of the Royal Academy of Arts, and where he died at the advanced age of eighty-nine.

His drawings from the old masters, chiefly after Raffaele, Dominichino, Guercino, and Daniel de Volterra, have been much admired, and have sold for considerable sums; and besides the plates mentioned above, he engraved "St. Peter curing the lame Man," a large upright from Civoli, which is one of his early works, and in the dark manner of his father; "The Descent from the Cross," after Daniel de Volterra, a very fine engraving; the "Martyrdom of St. Sebastian," after Dominichino, an upright, and equally meritorious; "The Holy Trinity," from Guido; and a few other plates from A. Carracci, Lanfranc, and Louis Dorigny, his brother.

When the late period of life at which Dorigny began to use the graver is considered, the power which he acquired over that instrument must be regarded as extraordinary: the art with which he mingled the lines of the graver with those of the etching-needle is also much to be admired; and though it must be allowed that in copying Raffaele's

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forms he has often lost much of their exquisite grace and chasteness, and has rendered the characters of his heads but coarsely, yet on the whole he rides his graphic Pegasus with masculine grace. There is a manly energy and freedom in his style, bridled by simplicity; his shadows are full-toned, clear, and rich; and though his flesh be deficient in characteristic texture, the lines are often conducted over his draperies with unprecedented freedom and elegance, of which the figure of "St. Paul preaching at Athens," and that of the same apostle in the Cartoon of "Elymas the forcerer, struck blind," may be sufficient examples. Indeed, a critical eye may trace in the arrangement of Dorigny's lines, the rudimental principle of that simple system of drapery-engraving, which Mr. Heath and his school have since polished and rendered more perfect.

Charles Dupuis, who has been mentioned as the assistant of Dorigny, engraved some plates from the history of the misfortunes of Charles I., but the climate of England not agreeing with his constitution, he returned to Paris, and died there in the year 1743. A younger brother of his also came over, but returned in disappointment, finding British encouragement less than he had expected.

Claude Dubosc quitted Dorigny's service at the same time with Dupuis, but settled here, and, with more boldness than ability, undertook to engrave the Cartoons on a smaller scale than Dorigny's for the printfellers, who presumptively, were *cunning* enough to think, not of transcribing, but of *underjelling* the engravings of that distinguished artist. He next engaged himself to engrave a set of the duke of Marlborough's battles, for which he received at the rate of four-score pounds *per* plate. At first he had no assistance but what he received from du Guernier, but afterwards sent to Paris for Beauvais and Baron, who assisted him in the completion of these engravings. He now commenced printfeller, and published in numbers a translation of Picart's "Religious Ceremonies," in engraving which, he was assisted by Gravelot and Scotin, who came over to England for that purpose.

Dubosc's style of engraving is heavy, and his drawing of the naked very indifferent, which renders it not improbable that the worst parts of Dorigny's Cartoons are by his hand. Among his works, which are not very numerous, the "Contiaence of Scipio," from that picture of Nicholas Poussin, which was in the Houghton Collection, is probably the best.

Of the Winstanleys, as engravers, little can be said. Henry (the elder) etched several views of "The Palace at Audley-end;" and Hamlet (son of the former) etched twenty plates from the earl of Derby's Collection, and a set of prints from sir James Thornhill's "Cupola of St. Paul's Cathedral."

The father was projector and builder of the Eddystone light-house, and when it was thrown down by a dreadful tempest, was buried in its ruins. To his etchings of Audley-end, which were dedicated to king James II., he added an inscription in honour of sir Christopher Wren, and the plates being "reserved by the descendants of the earl of Suffolk," (according to lord Orford,) the impressions are now become scarce.

The son studied under the Knellers, and afterwards in Italy, yet he made no great figure as an artist. The nobleman quoted above, speaks of his house at Littlebury, where "were several mechanic tricks to surprize the populace, which were known by the name of "Winstanley's Wonders." These childish contrivances, I suppose, he learned in Italy, where they do not let their religion monopolize *all* kinds of legerdemain. In the noble palace of the villa

Borghese," adds his lordship, "was the noble statue of Seneca dying in the bath, and a devil that started out of a clock-case as you entered the room." Hamlet painted a few portraits with moderate ability.

The assistance which du Guernier rendered to Dubosc in his "Battles of the Duke of Marlborough," has been already mentioned. He studied under Chatillon, at Paris, and came to England in 1708. The London Academy, as it was called, was then establishing under the auspices of sir Godfrey Kneller, and du Guernier was chosen director of it, and continued to to the time of his death, which was occasioned by the small-pox, and happened Sept. 19, 1716, when he was but thirty-nine years of age. Besides his share of the Marlborough's battles, he engraved a few frontispieces, chiefly for plays, and, at the instance of lord Halifax, a large print of "Lot and his Daughter," from Caravaggio, and the portraits (large) of the "Duke and Duchels of Queensbury."

Bickham, Coignard, Johnson, George King, Nichols, and Simpson, who were all contemporary, are passed over for reasons which have formerly been given. John Kip engraved a considerable number of the palaces and seats of the nobility and gentry from Knyff, but they were indifferent, and were far from advancing the art.

It has been already mentioned, that Girard Scotin, the younger, came over from Paris to assist Dubosc. He studied under his father, who was an engraver and a disciple of De Poilly, but was a man of more industry than talent. His principal works are, "Belisarius," a large plate, after Vandyke, or Murillo, for it does not appear to be ascertained to which of these masters this celebrated picture should be ascribed; and "Alfred receiving the Account of the defeat of the Danes," from Blakeney. He also assisted Hogarth in some of his series, and engraved a few portraits.

Henry Gravelot, who came hither at the same time, was an artist of much more taste. His opportunities of observing nature had been more various and extensive than fell to the lot of many of his contemporary professors of the fine arts. He was a native of France, but had been in America as secretary to the governor of Canada: the climate disagreeing with him, he returned to Paris, whence he was invited to England by Dubosc.

He was for some time employed in Gloucestershire, drawing churches and antiquities, and, according to lord Orford, he drew the monuments of kings for Vertue. For the booksellers he made a very great number of designs, both historical and ornamental, wherein his taste and the fertility of his inventive powers are eminently conspicuous. From many of these he made etchings, as also many after the designs of Hayman, and the same taste and facility attended his etching-needle, which is conspicuous in the productions of his pencil.

In sir Thomas Hanmer's and Theobald's editions of Shakespeare, a great number of his engravings, and several of his designs, may be found. His principal work on copper is a large print of "Kirkstall Abbey," which Strutt speaks of as a fine specimen of his abilities, but which the present writer has not seen. He lived to the age of seventy-four, and died at Paris in the year 1773.

Bernard Baron was also transplanted hither from the continent by Dubosc, who appears to have been a great speculator in this species of culture. They differed, and went to law, on the subject of a set of engravings after Dr. Mead's pictures from the history of Ulysses, by Rubens, but were afterwards reconciled, and went to Paris together in the year 1729. After engraving some plates for Mous-

Crozat,

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Crozat, from the royal collection, he returned to England, and here he executed a considerable number, and had the satisfaction of working after some of the finest pictures in the kingdom.

His style is chiefly studied from that of sir Nicholas Dorigny, generally coarse, but occasionally somewhat softened and incorporated with the prevailing taste of the French school. His principal engravings are as follow, and are all large plates. "Vandyke's equestrian figure of Charles I." from the royal gallery at Kensington; the "Cornaro family," from the celebrated Titian at Northumberland house; the "Pembroke family," from the same master, at Wilton house; the "Nassau family," from the same, in the collection of earl Cowper; the "Jupiter and Antiope," also after Titian, executed in Paris; "Henry VIII. granting the charter of incorporation to the company of Surgeons" from Holbein. Baron died in Panton square, Piccadilly, in the year 1762.

Chereau, the younger, was also imported from Paris by Dubosc, and engraved a profile likeness of George I. which possesses some merit, but finding or fancying, that his talents were undervalued in England, he soon returned.

Michael Vandergucht, originally of Antwerp, studied under Boutats, but was the master of Vertue. The year of his arrival in England is not known: here, however, he met with some encouragement, and resided in London. His chief employment was to engrave anatomical figures, but he sometimes undertook subjects of a different kind. His master-piece, according to Vertue, was a portrait of Mr. Savage. He also engraved a very large plate of the royal navy from Baston.

John Vandergucht, son of the preceding, was born in 1697, and acquired from his father the manual practice of engraving, but studied drawing under Lewis Cheron, and afterwards at the London Academy. He was employed by Chefelden to draw and engrave the subjects for his Osteology, a work by which he obtained much credit; and he had a considerable sum for engraving "Sir James Thornhill's cupola of St. Paul's cathedral." The six academy figures which he engraved from the drawings of his master Cheron, shew that he understood drawing better than he could manage the graver. He also engraved Poussin's "Tancred and Erminia."

He produced a great number of book-plates, of which the merits were not great, and some were also engraved by his brother Gerard Vandergucht, who was a great dealer in pictures, lived to the age of eighty years, and died in 1778 at his house in Brook-street, the same that is now inhabited by Tresham the academician.

George Vertue was born in the year 1684, in the parish of St. Martin in the Fields, London, and was put apprentice at the age of thirteen to a master who engraved heraldry on plate. This person being obliged to leave the kingdom by the time Vertue had been three or four years under him, our artist returned to his parents. He then gave himself entirely to the study of drawing for two years, when he became the pupil of Michael Vandergucht; with whom he engaged to remain three years, but protracted his stay to seven, when he quitted his master on handsome terms, and began to engrave book-plates for himself.

"The art was then, says lord Orford, at the lowest ebb in England. The best performers were worn out; the war with France shut the door against recruits; and the animosity of faction diverted public attention from the common arts of amusement." At this period our young engraver was recommended to the notice of sir Godfrey Kneller, whose reputation sustained the remaining dignity of art:

Kneller befriended him, and he was soon after employed by lord Somers, who, according to Strutt, "rewarded him generously," and by his talents and industry he was now enabled to support his widowed mother, with her family of several children.

In the year 1711 he began to study at the academy which sir Godfrey had recently instituted; where he continued to draw for some years with great assiduity. He had now produced his famous head of archbishop Tillotson, which lord Orford emphatically calls "the ground-work of his reputation," and soon after the accession of the present royal family, he published a large portrait of king George I. from a picture by Kneller. "As it was the first portrait of that monarch, many thousands were sold, though by no means a laborious or valuable performance. However it was shewn at court, and was followed by his undertaking to engrave portraits of the prince and princesses."

Vertue had now commenced those biographical and antiquarian researches, in which he has been so eminently successful. In these pursuits he made many journeys to different parts of our island, and his time was industriously employed in making drawings, catalogues, and various memoranda.

"His thirst after British antiquities soon led him to a congenial Mæcenas. That munificent collector, Robert Harley, second earl of Oxford, distinguished the merit and application of Vertue;" and the invariable gratitude of the latter, expressed on all occasions, attests at once the bounty of his patron and his own humility.

Another of his patrons was Heneage Finch, earl of Winchelsea, whose portrait he painted and engraved, and who, being president of the Society of Antiquaries on its revival, in 1717, appointed Vertue, who was a member, engraver to that learned body.

Henry Harc, the last lord Coleraine, was also one of his antiquarian benefactors, and the university of Oxford employed him for many years to engrave the head pieces for their almanacks.

With lord Orford, lord Coleraine, and Mr. Stephens the historiographer, he made several tours to various parts of England. For the former he engraved portraits of "Matthew Prior," "sir Hugh Middleton," and other distinguished men: for the duke of Montague he engraved, "sir Ralph Windwood;" for sir Paul Methuen, the portraits of "Cortez," and "Archbishop Warham" from Holbein's original at Lambeth; and for lord Burlington, Zucchero's "Queen Mary of Scotland," a plate which evinces more felicity, and a better taste of execution, than most other of his works.

In the year 1727 he travelled with lord Orford to Burreleigh, Lincoln, Welbeck, Chatsworth, and York, at which latter place he obtained from Francis Place, whom we have mentioned, many of those anecdotes of Hollar which are inserted in his biography.

In the next year, the duke of Dorset invited him to Knowle. From the gallery there, he copied the portraits of several of the poets. Here he was on fairy ground, and Arcadia was on the confines; but he was disappointed on an excursion to Penshurst, at not finding there any portrait of sir Philip Sydney.

In 1730 appeared his twelve heads of distinguished poets, one of his capital works, which he meant to have followed with the portraits of other eminent men, arranged in classes, but this scheme was taken out of his hands by the Messrs. Knapton; and there is reason to think that Vertue's rigid regard for veracity, which made him justly scrupulous of authenticating the likenesses of deceased characters without the clearest proofs, and not the superior taste or discernment

of the Knapton's, made them engage the superior talents of Houbraken and Gravelot, to finish a work which our artist had begun, and had himself projected.

His next considerable production was, the portraits of king Charles I. and the loyal sufferers in his cause, with their characters subjoined from Clarendon. But this was scarcely finished, before Rapin's history of England appeared, "a work, (says he,) which had a prodigious run, insomuch that it became all the conversation of the town and country, and the noise being heightened by opposition and party, it was proposed to publish it in folio by numbers, of which thousands were sold every week." The Messrs. Knapton engaged Vertue to accompany it with effigies of the kings and other suitable embellishments, an undertaking which occupied three years of his life. He presented a copy of this work, when finished, richly bound, to the prince of Wales, at Kensington.

He now renewed his topographical journies, accompanied sometimes by the earl of Leicester, sometimes by lord Oxford, and sometimes by Roger Gale the antiquary; and between the years 1734-38, visited St. Albans, Northampton, Oxford, Penshurst, Warwick, Coventry, Stratford, and travelled through the counties of Kent, Sussex, and Hampshire, where he made various sketches, drawings, and notes, always presenting a duplicate of his observations to his patron lord Oxford.

In 1739, he travelled eastward with lord Coleraine, through the counties of Essex, Suffolk, and Norfolk, stopping as usual to make drawings and observations at every memorable church, seat, or other spot congenial to his pursuits. In 1741 he lost his noble friend and patron the earl of Oxford, who died on the 16th of June. But his merit and modesty still raised him benefactors. The countess dowager of Oxford, even, alleviated his loss, and the duchess of Portland (their daughter), the duke of Richmond, and lord Burlington, did not forget him among the artists whom they patronized.

In the year 1749, he found a yet more exalted protector in the prince of Wales, whom he often had the honour of attending, and to whom he sold many prints, miniature pictures, &c.

"He had now reason to flatter himself with permanent fortune. He saw his fate linked with the revival of the arts he loved; he was useful to a prince who trod in the steps of the accomplished Charles, and no Hugh Peters (adds lord Orford) seemed to threaten havoc to the growing collection." But the death of this prince suddenly blasted the hopes of Vertue, and affected him with considerable dejection of spirits, from which, according to his lordship, he never perfectly recovered. He died in the year 1756, and was buried in the cloisters of Westminster abbey.

By the majority of connoisseurs, Vertue's talents as an engraver have been over-rated. He rarely rises above mediocrity, and sometimes sinks below it, yet the present writer must freely declare his surprise when he first saw a good impression of Vertue's print of "Mary Queen of Scotland," after Zuccherò, at the superior merits which it displayed.

A much more copious biography of this artist will be found in the printed works of lord Orford, and also a catalogue of his engravings (amounting to near five hundred!) classed under the heads of "Royal Portraits," "Noblemen," "Bishops," "Poets," "Antiquaries," "Tombs," "Historic Prints," "Coins," "Medals," "Frontispieces," &c. &c. &c.

To all the distinguished notice and patronage with which

Vertue was honoured, and to the repeated praise of lord Orford, who was one of his friends, he was entitled less by his talents as an artist, or native independence of mind, than by his patience and accuracy of research as an antiquary, and as his noble biographer cannot boast of his genius, it might, perhaps, have been thought that he did right to dwell with so much seeming approbation on his diligence and humility; if he had not himself left posterity such abundant room to wish that he had respected genius more, and been less completely satisfied with the blandishments, which plodding mediocrity may with little difficulty acquire.

We now approach the less patronized and more highly respectable name of William Hogarth, upon whose valuable works as painter and engraver, so many volumes might be profitably written. The able pen to which the biography of the former description of artists is confided, will doubtless claim Hogarth as a painter, yet, as he was both by education and long practice an engraver also, he must not here be passed in silence.

In the narrative which he left behind of his own life and opinions, where his philosophy is not less conspicuous than his manly frankness, and where his foresight with respect to the well-being of British art has shewn itself prophetic, he informs us, that he was born in London in the year 1697; that during his infancy he derived uncommon pleasure from shews and mimicry; that an early access to a neighbouring painter drew his attention from play; and that when at school his exercises were remarkable for the ornaments with which they were adorned.

He was scarcely more attracted by art, than driven from literature, which was the profession of his father. "Besides the natural turn I had for drawing," proceeds he, "I had before my eyes the precarious situation of men of classical education. I saw the difficulties under which my father laboured, and the many inconveniences he endured from his dependance being chiefly on his pen, and the cruel treatment he met with from booksellers and printers. It was, therefore, very conformable to my own wishes that I was taken from school, and served a long apprenticeship to a silver-plate engraver.

"I soon found this business in every respect too limited. The paintings of St. Paul's cathedral and Greenwich hospital, which were at that time going on, ran in my head, and I determined that silver-plate engraving should be followed no longer than necessity obliged me to it.

"Engraving on copper was, at twenty years of age, my utmost ambition. To attain this it was necessary that I should learn to draw objects something like nature, instead of the monsters of heraldry, and the common methods of study being much too tedious for one who loved his pleasure, I was led to consider whether a shorter road than that usually travelled was not to be found. I had learned by practice to copy with tolerable exactness in the usual way; but it occurred to me that there were many disadvantages attending this method of study, as having faulty originals," &c. Drawing in an academy, (Hogarth means a school,) though it should be after the life, will not make the student an artist, for as the eye is often taken from the original to draw a bit at a time; it is possible he may know no more of what he has been copying when his work is finished, than he did before it was begun.

"More reasons, not necessary to enumerate, struck me as strong objections to this practice, and led me to wish that I could find the shorter path, six forms and characters in my mind, and instead of copying the lines, try to read the language, and if possible find the grammar of the art, by bring-

ing into one focus the various observations I had made, and then trying, by my power on the canvas and copper, how far my plan enabled me to combine and apply them to practice.

"For this purpose, I considered what various ways, and to what different purposes the memory might be applied; and fell upon that which I found most suitable to my situation and idle disposition.

"Laying it down first as an axiom, that he who could by any means acquire and retain in his memory perfect ideas of the subjects he meant to draw, would have as clear a knowledge of the figure as a man who can write freely hath of the twenty-four letters of the alphabet and their infinite combinations (each of them being composed of lines), and would consequently be an accurate designer.

"This I thought my only chance for eminence, as I found that the beauty and delicacy of the stroke in engraving was not to be learnt without much practice, and demanded a larger portion of patience than I felt myself disposed to exercise. Added to this, I saw little probability of acquiring the full command of the graver in a sufficient degree to distinguish myself in that walk, nor was I at twenty years of age much disposed to enter on so barren and unprofitable a study as that of merely making fine lines.

"I therefore endeavoured to habituate myself to the exercise of a sort of technical memory, and by repeating in my own mind the parts of which objects were composed, I could by degrees combine and put them together. Thus, with all the drawbacks which resulted from the circumstances I have mentioned, I had one material advantage over my competitors, *viz.* the early habit I thus acquired of retaining in my mind's eye whatever I intended to imitate. Sometimes, but too seldom, I took the life for correcting the parts I had not perfectly enough remembered, and then I transferred them to my compositions."

Such parts only of Hogarth's valuable narrative as are to the present purpose, are here extracted. Those who would read the whole are referred to "A supplement to Hogarth illustrated, compiled from his original manuscript by John Ireland," 1798, published for the author by Nicol, and the Messrs. Boydell. Our artist proceeds:

"Instead of burthening the memory with musty rules, or tiring the eyes with copying dry and damaged pictures, I have ever found studying from nature the shortest and safest way of attaining knowledge in art."—"Had I not sedulously practised what I thus acquired, I should very soon have lost the power of performing it."

In a subsequent chapter he says, "in pursuing my studies, I made all possible use of the technical memory which I have before described, by observing and endeavouring to retain in my mind lineally, such objects as best suited my purpose, so that be where I would my eyes were open, I was at my studies, and acquiring something useful in my profession, and thus the more striking objects, whether of beauty or deformity, were by habit the most easily impressed and retained in my imagination. A redundancy of matter being by this means acquired, it is natural to suppose I introduced it into my works on every occasion that I could.

"By this idle way of proceeding, I grew so profane as to admire nature beyond the first productions of art, and acknowledge I saw, or fancied, delicacies in the life, far surpassing the utmost efforts of imitation.

"To return, the instant I became master of my own time, I determined to qualify myself for engraving on copper. In this I readily got employment; and frontispieces to books, prints to Hudibras, &c. soon brought me into the way. But the tribe of booksellers remained as my father had left

them when he died, (about five years before,) which was of an illness occasioned partly by the treatment he met with from this set of people, and partly by disappointment from great men's promises; so that I doubly felt this usage, which put me upon publishing on my own account. But here again I had to encounter a monopoly of print-sellers, equally mean and destructive to the ingenious; for the first plate I published, called "The Taste of the Town," had no sooner begun to take a run, than I found copies of it in the print-shops vending at half price, while the original prints were returned to me again, and I was thus obliged to sell the plate for whatever these pirates pleased to give me, as there was no place of sale but at their shops. Owing to this and other circumstances, by engraving until I was near thirty, I could do little more than maintain myself."

At the age of two and thirty, he married the daughter of sir James Thornhill, and commenced painter of small conversation pieces, which, having novelty, succeeded for a few years, but were afterwards not sufficiently profitable to pay the expences of his family. "I therefore," says he, "turned my thoughts to a still more novel mode, *viz.* painting and engraving modern moral subjects, a field not broken up in any country or any age.

"I thought that both writers and artists had overlooked that intermediate species of subject, which may be placed between the sublime and the grotesque; I therefore wished to compose pictures on canvas, similar to representations on the stage.

"Ocular demonstration will carry more conviction to the mind of a sensible man than all he would find in a thousand volumes; and this has been attempted in the prints which I have composed.

"After having had my plates pirated in almost all sizes, I, in 1735, applied to parliament for redress, and obtained it in so liberal a manner, as hath not only answered my own purpose, but made prints a considerable article in the commerce of this country; there being now more business of this kind done here, than in Paris or any where else.

"The dealers in pictures and prints found their craft in danger, by what they called a new-fangled innovation. Their trade of living and getting fortunes by the ingenuity of the industrious has, I know, suffered much by my interference; and if the detection of this band of public cheats and oppressors of the rising artists be a crime, I confess myself most guilty."

The obtainment of this act, which secures the copy-right of engravings, was certainly a great benefit, not only to artists, but to the public, and even to the print dealers themselves, who now were secured in the possession of any engraved property which they might purchase. The remainder of Hogarth's narrative chiefly respects his profession as a painter, and the incidents of his private life. His reputation was now extending far and wide; he had published his "Harlot's Progress" in six plates, beside many other prints of less importance, which Mr. Ireland has enumerated, and now brought forth his "Rake's Progress" in eight, which are replete with moral lesson and the most pointed satire. Swift about this time wrote

"How I want thee, hum'rous Hogarth!  
Thou, I hear, a pleasant rogue art,  
Were but you and I acquainted  
Ev'ry monitor should be painted:  
You should try your graving tools  
On this odious group of fools, (the Legion Club.)  
Draw the beasts as I describe 'em,  
Form their features, while I gibe 'em."

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In the course of the next year he engraved "The Sleeping Congregation;" "The Distressed Poet," which in its original state represents Pope thrashing the bookfeller Curl, and "The Arms of the Undertaker's Company." He also published a whole length portrait of lady Byron, from a picture of his own, engraved in mezzotint by Faber.

In the year 1737, he produced only "The Lecture." In 1738, he published "Morning," "Noon," "Evening," and "Night." The third plate was engraved by Baron, except the figure of the girl with a fan, which was an afterthought of Hogarth's, and is from his own graver. The "Salisbury" flying coach in the engraving of Night, is thought to be a satire on a certain peer who delighted to drive his own horses. He also produced this year "Strolling Actresses in a Barn;" the original picture of which he sold to Francis Beckford, esq. for 27*l.* 6*s.* who returned it, though charged at so low a price, and it was afterwards sold to Mr. Wood of Littleton for the same sum.

Until the year 1741, he published nothing more, when "The enraged Musician" made its appearance, in which the principal figure has been spoken of as being the portrait of Cervetto, but on better authority, is now supposed to be that of Feslin.

In 1742, he engraved and published the portrait of "Martin Foulkes, esq.," "The Charmers of the Age," (a sketch,) and "Taste in High Life," which latter is replete with the most pointed satire on the reigning follies and fashions which then prevailed in the higher circles. A more sophisticated assemblage of objects cannot be imagined, and the elderly lady of the Chesterfield school, who holds the small Dresden tea-cup with so much exquisite delicacy of fingering, and a countenance so truly expressive of the affectation of intense enjoyment of its beauties, has never been surpassed.

From this time, till the year 1745, he was employed on his "Marriage A-la-Mode," and only published three portraits, engraved by other artists, from his own pictures. The series of six plates of the Marriage A-la-mode were chiefly engraved by Scotin and Baron, who have been already mentioned, and S. Ravenet. Hogarth engraved on the plates from time to time, which has occasioned those variations which certain adorers of rarity look for with more eagerness, than they appear to possess feeling or judgment in estimating the general design. This series comprehends indeed master-pieces of art in their kind, and places Hogarth's fame on the broadest and most durable basis.

In the following year, he etched and published his characteristic portrait of "Lord Lovat," which, by those who have seen him, has been attested to be "in air, character, and features, a most faithful resemblance of the original." He is represented seated in his old fashioned chair with the lofty back, and in the act of enumerating by his fingers the rebel forces. It is etched with uncommon spirit, and what was of more pecuniary importance, (adds Mr. Ireland,) was so well timed, that Mrs. Lewis told me, they for many weeks received more than ten pounds a day from the sale. It was published the 25th August, 1746, and the peer was beheaded the 9th April 1747, in the eightieth year of his age. The portrait of Garrick, in the character of Richard III. engraved by Hogarth, and C. Grignion, was also published this year, of which Mr. Grignion, (who has done so much for an art which has done so little for him, and is still living,) says, that Hogarth etched the head and the hands, but erased the head twice before he could satisfy himself. In the course of the present year Hogarth also issued the subscription ticket to "The March to Finchley."

The series of "The Idle and Industrious Apprentices,"

in twelve plates, designed and engraved by William Hogarth, were published in 1747. Of this series, so replete with moral lesson, and heightened with such admirable strokes of humour, Hogarth himself has written as follows. "The effects of idleness and industry exemplified in the conduct of two fellow-<sup>3</sup>prentices. These twelve prints were intended for the instruction of young people, and, considering the persons they were intended to serve, I have endeavoured to render them intelligible and cheap as possible:" (the twelve were originally published at the low price of twelve shillings.) "Fine engraving is not necessary for such subjects, if what is infinitely more material, *viz.* character and expression, be properly preserved." "The Stage Coach or Country Inn Yard," and two portraits of Gibbs the architect, engraved by Baron and Mc. Ardell, he also published in the course of this year.

In 1748, he etched a view of Mr. Ranby's house at Chiswick, but nothing else of any consequence. In 1749, was produced "The Gate of Calais," or, "Roast Beef of Old England." It appears that soon after the peace of Aix-la-Chapelle, Hogarth went over to France, and as he was sauntering about at Calais, and contemplating the difference between England and France, he observed over the gate of the town some appearance of the arms of England; he was prompted to make a sketch, and being observed, was taken into custody: his own account of this affair is as follows: "Not attempting to cancel any of my sketches or memorandums, which were found to be merely those of a painter for his private use, without any relation to fortification, it was not thought necessary to send me back to Paris." (This word contradicts the assertion of those who say he never went further into France than Calais.) "I was only closely confined to my own chamber till the wind changed for England; where I no sooner arrived, than I set about the picture (of roast beef) and made the gate my back ground; and in one corner introduced my own portrait, which has generally been thought a correct likeness, with the soldier's hand upon my shoulder. By the fat friar, who stops the lean cook that is sinking under the weight of a vast surloin, and two of the military who are bearing off a great kettle of soup maigre, I meant to display to my own countrymen the striking difference between the food, priests, soldiers, &c. of two nations so contiguous, that in a clear day one coast may be seen from the other. The melancholy and miserable highlander, browsing on his scanty fare, consisting of a bit of bread and an onion, is intended for one of the many that fled from this country after the rebellion in 1744." In the course of this year, he also engraved and published his own portrait in a cap, with his favourite pug dog and palette, on which is drawn that mysterious "line of beauty and grace," which excited, and was meant to excite, the attention of the public in no slight degree.

Fourteen years afterwards, Hogarth erased his own head from the plate, and in its place engraved a caricature of Churchill as a bear, and inscribed it, "The Bruifer C. Churchill (once the Reverend!) in the character of a Russian Hercules," &c. &c.

In the year 1750, appeared his "March to Finchley," which was engraved by Luke Sullivan, and dedicated to the king of Prussia. The original picture he presented to the Foundling hospital. "Gin-lane" and "Beer-street" appeared in the following year, of which prints Hogarth himself gives the following account. "When these two prints were designed and engraved, the dreadful consequences of gin drinking appeared in every street. In Gin-lane, every circumstance of its horrid effects is brought to view in ter-

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*rorem.* Idleness, poverty, misery, and distress, which drive even to madness and death, are the only objects that are to be seen; and not a house in tolerable condition, but the pawn-brokers and gin shop."

"Beer-street," its companion, was given as a contrast, where that invigorating liquor is recommended in order to drive the other out of vogue. Here all is joyous and thriving, &c. &c."

He also now published his "Four Stages of Cruelty," of which he has thus usefully, honestly, and proudly written. "The leading points in these, as well as the two preceding prints, were made as obvious as possible, in the hope that their tendency might be seen by men of the lowest rank. Neither minute accuracy of design, nor fine engraving, were deemed necessary, as the latter would have rendered them too expensive to the persons to whom they were intended to be useful: and the fact is, that the passions may be more forcibly expressed by a strong bold stroke, than by the most delicate engraving." (The artist probably meant this observation to be applied to the violent, and not to the tender passions.) "To expressing them as I felt them, I have paid the utmost attention, and as they were addressed to hard hearts, have rather preferred leaving them hard, and giving the effect by a quick touch, to rendering them languid and feeble by fine strokes and soft engraving, which require more care than can often be attained, except by a man of a very quiet turn of mind. Masson, who gave two strokes to every particular hair that he engraved, merited great admiration, but at such admiration I never aspired, neither was I capable of attaining it if I had.

"The prints were engraved with the hope of, in some degree, correcting that barbarous treatment of animals, the very sight of which renders the streets of our metropolis so distressing to every feeling mind. If they have had this effect and checked the progress of cruelty, I am more proud of having been the author, than I should be of having painted Raphael's cartoons."

The humorous "Paul before Felix" was also the produce of this year, which in the earliest impressions is subscribed, "designed and scratched in the true Dutch taste by William Hogarth," and in the subsequent impressions (where he has introduced a little fiend sawing off the leg of the Apostle's stool,) "designed and etched in the ridiculous manner of Rembrandt by Wm. Hogarth." This whimsical little print was originally given with the receipts to the subscription for the serious "Paul before Felix," and "Pharaoh's Daughter," both of which he produced in the course of the ensuing year.

The former of these he engraved from his original picture in Lincoln's-inn Hall; another plate of which subject, with some variations, was published by Hogarth at the same time, (which is remarkable, both being dated Feb. 5,) engraved by Luke Sullivan.

"Moses brought to Pharaoh's Daughter" is engraved by William Hogarth and Luke Sullivan from the original painting in the Foundling hospital, and was also published on the same day.

His "Columbus breaking the Egg" was given in the November of this year, with the receipt for "the first payment of a short tract in quarto, called the Analysis of Beauty; wherein forms are considered in a new light;" and in the next year came forth his far famed "Analysis of Beauty, written with the view of fixing the fluctuating ideas of taste," and embellished with two folded and very curious illustrative engravings.

With some small literary assistance from Dr. Hoadly, Mr.

Ralph, and Dr. Morell, he here maintained an hypothesis respecting undulating forms as essential to grace and beauty, the merits of which have, by subsequent writers on the subject of taste, been variously estimated, but of late have been utterly denied by Mr. P. Knight, who (in his analytical enquiry into the principles of taste) says, that the qualities of ease, grace, elegance, &c. do not "consist in any lines of beauty, or depend upon the impressions which any specific forms make on the organs of sight. On the contrary, they arise wholly from mental sympathies and the association of ideas."

An impression from the first plate of the Analysis of Beauty, which is in the possession of Mr. G. Baker, has this singularity, that the words "et tu Brute," are engraved on the pedestal on which stands Quin in the character of Brutus, which were afterwards erased.

In the year 1754 his admirable satire on parliamentary elections, which was engraved on four plates, began to appear. Of the first plate, which is "An Election Entertainment," it has been said that Hogarth completed the engraving without taking from it a single proof by which to ascertain the progress of his work. It might be so, but if this were wise it would more frequently be practised, and Hogarth himself is known to have repented of his imprudence when a proof was taken.

This performance, in its original state, is by far the most finished and carefully executed of Hogarth's engravings, and he therefore, conscious of the superior pains which he had bestowed on it, inscribed beneath it, "painted, and the whole engraved by Wm. Hogarth," but these two words were afterwards erased, for the number sold was so considerable, that by the time the second plate of this series made its appearance, the first had been touched and retouched so often, that all the original and delicate lines were either hidden by others, or utterly obliterated, and it has been compared, wittily enough, to sir John Cutler's stockings, which, from frequent mending, from silk degenerated into worsted.

The second of the election series, of which the subject is "Canvassing for Votes" is engraved by C. Grignion, and was published in the year 1757. On which occasion Hogarth apologized in the public prints for the delay which had taken place, ascribing it to the difficulty of procuring able hands to engrave the plates. In the early impression this is an excellent engraving.

The third plate of this series is entitled "The Polling," is engraved by Hogarth and Le Cave, and was published in the following year.

The fourth plate, which completes the series, and is entitled "Chairing the Members," was also published in the course of the year 1758, and is engraved by Hogarth and Aveline.

In all these plates the satire of Hogarth is most poignant and abundant; and notwithstanding the number of portraits our engraver has introduced, his meaning is so general, that the election-prints continue to be applicable to the present time.

In the year 1758 he also engraved and published "the Bench," with explanations and illustrations of the words, "character" and "caricature." The print exhibits the inside of the court of common pleas, over which is the king's arms, and beneath are the portraits of the following judges, viz. honourable William Noel, sir John Willes; the lord chief justice; honourable Mr. justice (afterwards lord) Bathurst, and sir Edward Clive.

His own portrait, a whole length figure, was also the produce of this year, in which plate the face-only is engraved

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graven by Hogarth. He has here represented himself in profile, sitting, with a cap on his head, and engaged, in a very appropriate manner, in painting the muse of comedy. His analysis of beauty lies on the floor, and underneath is his title of serjeant painter to his majesty. It may be observed of this likeness, and that which he has introduced in his "Gate of Calais," that they both correspond much better with the bust of Hogarth, which was modelled by Roubilliac, and is now in the collection of M. G. Baker, than the three-quarter face which was published in 1749, and afterwards metamorphosed to that of Churchill the poet.

"The Cockpit," designed and engraved by W. Hogarth, was produced in 1759. In this engraving is introduced a portrait of Nan Rawlins, a very ugly old woman (commonly called Deptford Nan, and sometimes the duchess of Deptford), who is well remembered at Newmarket. She was a famous cock-feeder, and did the honours of the gentlemen's ordinary at Northampton. The figure with the hump back is that of Jackson, a once noted jockey, and the blind president is lord Albemarle Bertie, who constantly attended this refined and elegant diversion.

In the next three years he produced nothing of his own engraving, though he made some designs from Trilram Shandy; one for Brook Taylor's perspective, and a few others, which were engraved by Woollett, Ravenet, and Grignon: but in 1762, he produced his "Credulity, Superstition, and Fanaticism," which is chiefly meant to ridicule certain methodistical sectaries, and is preferred by lord Orford to all his other works "for deep and useful satire."

"The Times" was also produced in the year 1762. This is a political print, which Mr. Nichols explains as follows: "Europe on fire; France, Germany, and Spain, in flames, which are extending to Great Britain. This desolation continued and assisted by Mr. Pitt under the figure of king Henry VIII. with bellows encreasing the mischief which others are striving to abate. He is mounted on the stilts of the populace. A Cheshire cheese depends from his neck with 3,000*l.* on it. This alludes to what he had said in parliament, that he would sooner live on Cheshire cheese and a shoulder of mutton, than submit to the enemies of Great Britain. Lord Bute, attended by English soldiers, sailors, and highlanders, manages an engine for extinguishing the flames, but is impeded by the duke of Newcastle with a wheel-barrow full of monitors and North Britons, for the purpose of feeding the blaze. The respectable body under Mr. Pitt are the aldermen of London worshipping the idol they had set up; whilst the musical king of Prussia, who alone is sure to gain by the war, is amusing himself with a violin amongst his miserable country women. The picture of the Indian alludes to the advocates for retaining our West Indian conquests, which it was said would only increase excess and debauchery. The breaking down of the Newcastle arms, and the drawing up the patriotic ones, refer to the resignation of that noble duke, and the appointment of his successor. The Dutchman smoking his pipe and a fox peeping out behind him and waiting the issue; the waggon with the treasures of the Hermione; the unnecessary marching of the militia, signified by the Norfolk jigs; the dove with the olive branch, and the miseries of war, are all obvious, and perhaps need no explication."

In 1763, he published a caricature of "John Wilkes," esquire, drawn from the life, and etched in aquafortis by William Hogarth. To which was ironically added "this is a direct contrast to the print of Simon lord Lovat."

Of this caricature, Wilkes with his usual good humour

has been heard to say, that he was every day growing more and more like his portrait by Hogarth.

In the same year was published also, "the Bruiser C. Churchill," which has been already mentioned, and which neither added to his fame, nor in its consequences to his happiness.

"The Bathos," published in 1764, was his last engraving of any consequence, if not his very last work. In the month of October of this year being seventy-four years of age, he departed this life, and was buried in the church yard of Chiswick, where a monument, with an excellent epitaph by Garrick, is erected to his memory.

His engravings, like the tenour of his life, are characterized not by delicacy, but by strength of thought and expression. He did not aim at captivating by the beauty of his art, but at excelling by the power which he possessed of combining a number of particular and congenial truths into one impressive whole: agreeably to his own declarations, we perceive in his prints, that he discovers little dexterity in the arrangement of his lines, and still less solicitude about their beauty: yet in his pictures, and especially in those of the Marriage A-la-Mode, now in the collection of J. J. Angerstein, esquire, are some passages which no Dutch painter and no other painter could have more exquisitely touched. No artist whatever, and scarcely any man more than Hogarth, deserves the praise of original and independent thinking. His engravings are in some instances taken from no pictures, and his pictures from no books. Without having recourse to history or poetry he *invented* his subjects. The world of moral art "was all before him where to choose:" he marked out and took possession of an ample province for himself, replete with the riches of nature; a province which few have since dared to invade, and to which none have disputed his title.

Luke Sullivan, who has been already mentioned, was Hogarth's most valuable coadjutor in engraving: He was a native of Ireland, an eccentric character, and much addicted to women. Whilst engraving the march to Finchley (according to Mr. Ireland,) "Hogarth held out every possible inducement to his remaining at his house in Leicester square night and day; for if once Luke quitted it he was not visible for a month." If Hogarth gave him but one hundred pounds for this plate, as his biographers say, Sullivan's inducements to stay at home were certainly strong.

Beside what he did after Hogarth, Sullivan engraved "the Temptation of St. Anthony," after Teniers, and several garden scenes and other landscapes, which he drew from nature with some ability. He also painted miniatures with success. His own portrait may be seen in the character of an angel, in Hogarth's humorous print of "Paul before Felix." He died of a consumption in the year 1750.

About this time John Pine, whose portrait Hogarth painted in the manner of Rembrandt, was in good repute, but the years of his birth and death are uncertain. His chief works are, "the Ceremonies used at the revival of the order of the Bath;" "The Destruction of the Spanish Armada," from the tapestry of the house of lords; a splendid edition of Horace, illustrated with copies of antique bas-reliefs, gems, coins, &c. and a print of the house of commons.

The pastorals and Georgics of Virgil were published by his son after his death, adorned in the same manner as the Horace, but printed with letter-press types.

Now also flourished Arthur Pond, another native of England. He etched several portraits with freedom, taste, and spirit, among which are those of Mr. Pope (an excellent likeness), lord Bolingbroke, Dr. Mead, and himself. He

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was concerned with the Messrs. Knapton in publishing the volume of portraits of illustrious men which were engraven by Houbraken, Vertue, Gravelot, &c. and in promoting other meritorious works, particularly a set of plates from the great Italian masters in imitation of chalk and bistre drawings, which he accomplished with great success. He also etched a set of caricatures from the chevalier Ghisli, and a few landscapes, chiefly after Rembrandt.

Simon Francis Ravenet was another of Hogarth's occasional coadjutors. He was a native of France, came into England about the year 1750, and settled in London. In the latter part of his life he resided at Mother Red Cap's, near Kentish Town, where he died in 1774. He was of an amiable disposition and much respected, and had the honour of instructing both Ryland and Hall in the art of engraving.

The shadows in his engravings are deep toned, and his style both of drawing and engraving vigorous, though somewhat mannered. Beside what he produced after Hogarth, the following are esteemed among his best prints: "The Prodigal Son," (a large upright) from Sal. Rosa; "Lucretia deploring her Misfortune," from A. Cafali; "The Manifestation of the Innocence of the Princess Gunhelda," (its companion) from the same; "The Death of Seneca," (a large plate) from Lucca Giordano; "The Arcadian Shepherds," from N. Poussin; "The portrait of Lord Camden," from sir Joshua Reynolds. He is also the author of a considerable number of vignettes, book plates, and small portraits.

William Wynne Ryland was born in London in the year 1732. His genius for the fine arts manifested itself at an early period of his life, and he was accordingly placed under Ravenet. At the expiration of the term of his engagement he went to Paris, at that time the chief seminary of engraving, for improvement; and remained there five years.

Under the guidance of Boucher, who at that time led the fashion in art, he applied with great assiduity to the study of drawing, but did not neglect to improve himself also in the practical part of engraving. From the designs of this principal misleader of the taste of France, Ryland engraved several plates, of which the principal and probably the best engraving he ever performed, is rather a large work, of which the subject is "Jupiter and Leda."

He has here displayed great power as an engraver in lines. The print has a fine transparent tone; he has tempered the slimy touchiness of the French taste with a portion of Ravenet's solidity; the soft firmness of flesh is ably characterized in the figure of Leda, and the delicacy of the swan, and various textures of the surrounding objects, are rendered with much feeling and judicious subserviency to the principal parts.

In one of his amatory poems, M<sup>r</sup> Kenzie emphatically exclaims, "Alas! are there fashions in love!"—Alas! there are also fashions in fine art. Unmeaning glitter, unprecedented softness, unprincipled novelty, shall sometimes set aside for a while the truth and simplicity of nature, and the approbation of ages.

It was not, however, the false taste of Boucher that turned aside Ryland's talents from the mark at which he was evidently and successfully aiming, when he produced his "Jupiter and Leda," but a fashion of stippling which he learned in France, and introduced, with his own modifications, into England. Stippling with the graver had been occasionally practised both by Martin Schoen and Albert Durer in the very infancy of the art: the latter employed it in imitating the soft texture of beaver hats, as well as on

some other occasions. Perceiving that it was peculiarly expressive of softness, Agoltino Veneziano and Boulanger sometimes stippled their flesh, and Julio Campagnola his back grounds also. Almost a century afterward it was observed by De Marteau, who was now living, that by etching some of the dots of which this kind of engraving consists, and engraving others, very successful imitations of drawings hatched with chalk, might be produced. But Ryland employed stippling, so as rather to imitate such drawings as are stumped than such as are hatched with chalk, by which means he softened down all energy of style, and has left posterity to regret the voluntary emasculation of the powers he had manifested in the engraving, which is the subject of the above comments.

Soon after his return to England, he, however, engraved in lines a portrait of the queen, after Coates, and that portrait of his majesty, after Allen Ramsay, which Strange, from a misunderstanding either with the earl of Bute or Ramsay, had declined, but they possess neither the vigour nor taste of his "Jupiter and Leda." From this time he was appointed engraver to the king, and received an annual salary.

His subsequent engravings, in the chalk manner, are chiefly after Angelica Kauffman, and consist of four half-sheet circles, of which the subjects are, "Juno obtaining the Cestus of Venus," "A Sacrifice to Pan," "Cupid bound," and "Cupid asleep;" "Queen Eleanor sucking the poison from the wounded Edward I.;" (an excellent engraving of the kind;) "Lady Elizabeth Grey soliciting the restoration of her Lands;" "Maria;" from Sterne's Sentimental Journey, and "Patience," both upright ovals; also "King John ratifying Magna Charta." The last plate being left, by Ryland's unfortunate death, in an unfinished state, has since been completed by Bartolozzi. This artist also engraved in lines, "Antiochus and Stratonice," from Pietro de Cortona, and "The first Interview between Edgar and Elfrida," from Angelica Kauffman, both large plates.

Ryland's engravings in the novel manner were, for the most part, printed in red, and this manner of engraving soon obtained the name of "the red chalk manner," and was run after with avidity by the public. With so much heedless anxiety was it pursued, that people never stopt to consider whether even red chalk or stumped drawings themselves, of which these prints were professed imitations, were so good representations of nature, or afforded a means so happy and efficient of transfusing the soul of painting, as the art which previously existed, of engraving in lines, and which was then exercised in high perfection by Bartolozzi, Strange, Vivares, and Woollet: it was enough that it was new and red; Ryland and novelty led the way, and fashion and the print-sellers followed.

The print-dealers, upon mistaken notions of private advantage, are ever exhaulting the permanent hopes of the art. Like savages, who are reckless of the future, they cut down the tree in order to obtain its fruit. The novelty of chalk engraving, by calling forth their ignorant exertions, coincided with, and encreased, the mania of the public, and except for the landscapes of Vivares, Rooker, and Woollet, which required and exhibited more vigour and more detail of drawing than stippling could bestow; and that now and then an historical engraving by Strange and Bartolozzi, and the series from West's history of England, (of which the death of general Wolfe was the first,) attested the existence and maintained the dignity of the legitimate art, the engravers of Great Britain were compelled to feel, and silently to acknowledge, that

" Since

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“Since ignorance was bliss,  
’Twas folly to be wise.”

This mode of engraving, however, has since been greatly improved, and this improvement has been effected chiefly by living professors. For an account of its process and susceptibilities, see the article *STIPPLING*.

ENGRAVING, a mode or species of sculpture performed by incision. The radix of the word should rather be sought in the Hebrew, than in the Greek language, because the art itself was practised by the Hebrews and their Chaldean ancestors for centuries before Greece had existence.

There are several words used by the sacred historian to express or denote the work of the engraver. In the 25th chapter of Exodus, verse 9, פתח פתח signifies to make an opening, or incision; and hence come both the noun and its plural, פתוחים engravings.

One of the original senses of the root is *to plough up*, so that the engraver is called *the plougher*; and frequently the word אבן, *a stone*, is added for the sake of distinction, and both together may be properly translated *the plougher or engraver in stone*.

Mr. Strutt with much truth observes, that “no word can express more perfectly the operation of the engraver on metals of the present day (when performed simply with the graver) than the verb *to plough*.” His line is a furrow, and in cutting it he turns up the copper, or other metal, as the husbandman turns up the earth. The metal so turned up is termed the *burr*, which is afterwards removed with a tool termed by engravers a *scraper*.

In the 6th chapter of the first book of Kings, the word קלוי is used to express the hollowing out of the carved work upon the cherubim, palm trees, and open flowering in the sanctuary, which were afterwards filled up with gold; which word in the Latin Vulgate is rendered *sculpsit*; by others *calavit*; and by others *incidit*.

Engraving has been performed in different countries and at different periods of time, on various substances; chiefly on metals, wood, and the oriental precious stones, which are called gems, but with instruments that have varied but little since they were first invented. For the latter arts, see *GEM ENGRAVING* and *WOOD ENGRAVING*.

The metals upon which engraving is chiefly employed are copper and steel, the former for producing impressions on paper in various ways; the latter for striking coins, medals, &c.

Engraving on copper, for the purpose of producing impressions, may be divided into five species, engraving in aqua-tinta, for which see *AQUA-TINTA*; engraving in the chalk manner, for which see *STIPPLING*; engraving with aqua-fortis, for which see *ETCHING*; engraving on mezzotinto, for which see *MEZZOTINTO ENGRAVING*, and the original art of engraving *in lines*.

Engraving in lines, for the purpose of producing impressions on paper, may almost be said to be an art of modern invention, for though the ancients ornamented their pateras, armour, metal vases, &c. by this means, they appear never to have thought of printing from the incisions, or lines cut with the graver; nor was it thought of at all until about the middle of the 15th century, for which see our accounts of the *GERMAN* and *ITALIAN Schools of Engraving*.

This art is chiefly employed in representing historical subjects, landscapes, portraits, &c. &c. after pictures, or other designs made for the purpose.

It is performed, as we have stated, with the graver, dry point, or more frequently with the work of both these

tools, mingled with lines corroded with aqua fortis. For the first there need but little apparatus, and few instruments. The plate you work on being well polished, (for the method of preparing which, see *COPPER-PLATES*;) is covered over with a thin skin of virgin-wax, and on this the outline of the draught, or design, done in black lead, red chalk, or other ungummed matter, is laid; and rubbed down for the wax to take off. The design, thus transferred upon the wax, is traced through on the copper, with a point, or needle; then heating the plate, and taking off the wax, the strokes remain; to be followed, heightened, &c. according to the tenor of the design, with the graver, which is to be very sharp, and well tempered.

The dry point, or needle, which has been of late much used in engraving, is a tool like an etching point, which being drawn hard on the copper, cuts a stroke, and raises a burr; the burr is scraped off, and there remains a stroke more soft and delicate than can be produced in any other way. See *DRY POINT*.

In the adroit conduct of the graver and dry point the art chiefly consists; for which there are no rules to be given; all depending on the habitude, disposition, and genius, of the artist. However, some general observations and directions may not be improper. As the principles of engraving are the same with those of painting, a person cannot expect to attain any considerable degree of perfection in this art who is not a good master of design; and therefore he ought to be well acquainted both with perspective and architecture: for the former, by the proper degradations of strong and faint tints, will enable him to throw backward, or bring forward, the figures and other objects of the picture or design which he proposes to imitate; and the latter will teach him to preserve the due proportion of its several orders, which the painter often entrusts to the discretion of the engraver. In order to preserve equality and union in his works, the engraver should always sketch out the principal objects of his piece before he undertakes to finish them. Care should be taken that the graver be carried level upon the plate, and be pressed, as occasion requires, with greater or less force, carrying the hand as evenly as possible. In engraving straight lines, a less degree of pressure serves for those that are finer, and a greater is required to form the broader and deeper lines. In forming circular or curved lines, the hand and graver must be held steady, and the plate is to be moved upon the cushion under the graver. In large works a cushion is useless. The engraved work may be rendered more visible, by rubbing it over with a roll of felt, dipt in oil, and which is called an oil rubber. The strokes of the graver should never be crossed too much in the lozenge manner, particularly in the representation of flesh, because sharp angles produce the unpleasing effect of lattice-work, and take from the eye the repose which is agreeable to it in all kinds of picturesque designs: we should except the case of clouds, tempests, waves of the sea, the skins of hairy animals, or the leaves of trees, where this method of crossing may be admitted. But in avoiding the lozenge, it is not proper to get entirely into the square, which would give too much of the hardness of stone. In conducting the strokes, the action of the figures, and of all their parts, should be considered; and it should be observed how they advance towards, or recede from, the eye; and the graver should be guided according to the risings or cavities of the muscles or folds, making the strokes wider and fainter in the light, and closer and firmer in the shades. Thus the figures will not appear jagged; and the hand should be lightened in  
such

such a manner, that the outlines may be formed and terminated without being cut too hard: however, though the strokes break off where the muscle begins, yet they ought always to have a certain connection with each other, so that the first stroke may often serve by its return to make the second, which will shew the freedom of the engraver.

In engraving the flesh, the effect may be produced in the lighter parts, and middle tints, by long pecks of the gravers, rather than by light lines; or by round dots, or by dots a little lengthened by the graver, or, best of all, by a judicious mixture of these together.

In engraving the hair and the beard, the engraver should begin his work by laying the principal grounds, and sketching the chief shades in a careless manner, or with a few strokes; and he may finish it at leisure with finer and thinner strokes to the extremities. When architecture is to be represented, except it be old and ruinous buildings, the work ought not to be made very black; because, as edifices are commonly constructed either of stone or white marble, the colour, being reflected on all sides, does not produce dark shades, as in other substances. Where sculpture is to be represented, white points must not be put in the pupils of the eyes of figures, as in engravings after paintings; nor must the hair or beard be represented as in nature, which makes the locks appear flowing in the air; because in sculpture there can be no such appearances.

In engraving cloths of different kinds, linen should be done with finer and closer lines than other sorts, and be executed with single strokes. Woollen cloth should be engraved wide, in proportion to the coarseness or fineness of the stuff; and when the strokes are crossed, the second should be smaller than the first, and the third than the second. Shining stuffs, which are generally of silk or satin, and which produce flat and broken folds, should be engraved more hard and more straight than others, with one or two strokes, as their colours are bright or otherwise; and between the first course of lines other smaller must be occasionally introduced, which is called interlining. Velvet and plush are expressed in the same manner, and should always be interlined. Metals, as armour, &c. are also represented by interlining, or by clear single strokes. In architecture, the strokes which form the rounding objects should tend to the point of sight; and when whole columns occur, it is proper to produce the effect as much as possible, by perpendicular strokes. If a cross stroke is put, it should be at right angles, and wider and thinner than the first stroke. The strokes ought to be frequently discontinued and broken, for sharp and craggy objects. Objects that are distant towards the horizon should be kept very tender. Waters that are calm and still are best represented by strokes that are straight, and parallel to the horizon, interlined with those that are finer; omitting such places as, in consequence of gleams of light, exhibit the shining appearance of water; and the forms of objects, reflected from the water at a small distance upon it, or on the banks of the water, are expressed by the same strokes, retouched more strongly, or faintly, as occasion may require, and even by some that are perpendicular. For agitated waters, as the waves of the sea, the first strokes should follow the figure of the waves, and may be interlined, and the cross strokes ought to be very lozenge. In cascades, the strokes should follow the fall, and be interlined. In engraving clouds, the graver should sport, where they appear thick and agitated, in turning every way according to their form, and their agitation. If the clouds are dark, so that two strokes are necessary, they should be

crossed more lozenge than the figures, and the second strokes should be rather wider than the first. The flat clouds, that are lost insensibly in the clear sky, should be made by strokes parallel to the horizon, and a little waving; if second strokes are required, they should be more or less lozenge; and when they are brought to the extremity, the hand should be so lightened, that they may form no outline. The flat and clear sky is represented by parallel and straight strokes, without the least turning. In landscapes, the trees, rocks, earth, and herbage, should be etched as much as possible: nothing should be left for the graver but perfecting, softening, and strengthening. The dry point produces an effect more delicate than the graver can, and may be used to great advantage in linen, skies, distances, ice, and often in water, especially in small engravings. In most things it is proper to etch the shadows, only leaving the lighter tints for the dry point, graver, &c.

The other instruments, besides the graver and dry point, are, a cushion, or sand-bag, to lay the plate on, to give it the necessary turns and motions: a burnisher, round at one end, and usually flattish at the other, to rub out slips and failures, and to soften the strokes, &c. A scraper, to pare off the surface, on occasion, and remove the burr; and a rubber of black cloth, or hat, to fill up the strokes, that it may shew how the work proceeds: but the latter should be sparingly used.

ENGRAVING on steel, is chiefly employed in cutting punches, matrices, and dies, proper for striking coins, medals, and counters.

The method of engraving, with the instruments, &c. are the same for coins as for medals and counters: all the difference consists in their greater, or less relief; the relief of coins being much less considerable than that of medals; and that of counters still less than that of coins. The engraver in steel usually begins with punches, or punchions, which are in relief, and serve for making the creux, or cavities of the matrices, and dies; though sometimes he begins immediately with the creux; but it is only when the intended work is to be cut very shallow. The first thing is to design his figures; then he moulds them in white wax, of the size and depth required; and from this wax he graves his punch.

This punch is a piece of steel, or, at least, of iron and steel mixed; on which, before they temper, or harden it, the intended figure, whether a head, or a reverse, is cut, or carved, in relief. The instruments used in this *graving* in relief, which are much the same as those wherewith the finishing of the work in creux is effected, are of steel: the principal are, gravers of divers kinds, chisels, flatters, &c. when the punch is finished, they give it a very high temper, that it may the better bear the blows of the hammer, where-with it is struck, to give the impression to the matrice.

What they call *matrice*, or *matrix*, is a piece of good steel, of a cubic form, called also the *dye*, whereon the relief of the punch is struck in creux: it is called *matrice*, because in the cavities, or indentures, thereof, the coins, or medals, seem formed, or generated, as animals are in the matrix of their mother. To soften this steel, that it may more easily take the impressions of the punch, they make it red-hot; and, after striking the punch thereon in this state, they proceed to touch up, or finish, the strokes and lines, where, because of their fineness, or the too great relief, they are in any respect defective, with some of the tools above-mentioned.

The figure thus finished, they proceed to engrave the rest

of the medal; as the mouldings of the border, the engraved ring, letters, &c. all which, particularly the letters, and graving, or engraving, are performed with little steel punches, well tempered and very sharp. Add, that as they sometimes make use of puncheons to engrave the creux of the matrix, so, on some occasions, they make use of the creux of the matrix to engrave the relievo of the punch.

To see and judge of the engraving in creux, divers means have been devised to take the impressions therefrom, as the work proceeds; sometimes they make use of a composition of common wax, turpentine, and lamp-black; which, always retaining its softness, easily takes the impression of the part of the graving it is applied to; but this only serving to shew the work piece-meal, they have had recourse to other ways to shew the whole figure. The first by pouring melted lead on a piece of paper, and clapping the matrice thereon; the second, with melted sulphur, managed the same way; and the third, proper only where the graving is shallow, by laying a piece of soft paper on the graving, and over the paper a leaf of lead; when giving two or three blows with a hammer on the lead, the paper takes the impression of the work.

When the matrix is quite finished, they temper it, rub it well with a pumice-stone, and clean out the stone again with a hair-brush; and, lastly, polish it with oil and emery: in this condition it is fit for the mill, to be used to strike coins, medals, &c.

After the like manner are the matrices for casting of printing letters engraven. See *Letter Foundery*.

*ENGRAVING of seals, stamps, puncheons, marking irons, gilding irons,* and other matters, for goldsmiths, pewterers, bookbinders, &c. either in relievo, or indenture, is performed after the manner last described.

*ENGRAVING in wood.* See *CUTTING in wood,* and *Wood Engraving*.

*ENGRAULIS,* in *Ichthyology*, a name given, by some authors, to the anchovy, called also, by some, lycostomus, and, by others, halecula. See *ENCRASICOLUS*.

*ENGROSSING,* the writing a deed over fair and in proper legible characters. Among lawyers it more particularly means the copying of any writing fair upon parchment, or stamped paper. See *COPY, CALLIGRAPHUS, &c.*

*ENGROSSING,* in *Law*, denotes the getting into one's possession, or buying up large quantities of corn, or other dead victuals, with intent to sell them again. This must of course be injurious to the public, by putting it in the power of one or two rich men to raise the price of provisions at their own discretion. And so the total engrossing of any other commodity, with intent to sell it at an unreasonable price, is an offence indictable and fineable at the common law. (Cro. Car. 232.) And the general penalty for this offence, as well as for *forestalling* and *regrating* (which see), by the common law, (for all the statutes concerning them were repealed by 12 Geo. III. c. 71.) is, as in other minute misdemeanors, discretionary fine and imprisonment. (1 Hawk. P. C. 235.) Among the Romans these offences, and other mal-practices to raise the price of provisions, were punished by a pecuniary mulct. "Pœna viginti aureorum statuitur adversus eum, qui contra annonam fecerit, societatemve coierit quo annona carior fiat." (Inf. 48. 22. 2.)

*ENGSTLEN,* in *Geography*, a remarkable spring of Switzerland, in the canton of Berne, in the valley called Gentel. The water flows only from the beginning of May till the latter end of August, and that twice a day to-

wards eight o'clock in the morning, and towards four in the afternoon. This circumstance is considered as miraculous: the inhabitants fancy that providence purposely sends them this water in the season, and at the time when they are to water their cattle. Nothing, however, is more easily explained than this phenomenon. Many brooks issue from mount Engstlen, and form a small lake. In the summer months, the snow water causes this lake to overflow; and the melting of the snow begins with the day, and ceases towards night. F. I. Durand's *Statistique élémentaire de la Suisse*, 1795.

*ENGUELEGUINGIT*, a town of Africa, in the empire of Morocco, not far from Mogador.

*ENGUICHE*, in *Heraldry*, is applied to the great mouth of a hunting horn, when it has a rim of a different colour from the horn itself.

*ENGYSCOPE*, from *εἶς*, near, and *σκοπεω*, I observe, a machine better known under the name of microscope. See *MICROSCOPE*.

*ENGYTHECA*, from *εἶς*, near, and *θησαυρον*, repository, in *Antiquity*, a cup-board, or place where cups and other vessels used to be laid.

*ENGYUM, or ENGUYUM,* in *Ancient Geography*, a town of Sicily, situated near mount Maurus, at the springs of Alæsus. Cicero (in Verr.) represents it as one of the most considerable cities of that island. It was founded by the Cretans, and famous for a temple dedicated to Ceres, in which, it was constantly affirmed, certain goddesses, called the "Mothers," appeared from time to time. Plutarch says, that this temple was built by the Cretans, and dedicated to these goddesses so called, viz. Cybele, Juno, and Vesta. This writer adds, that in the temple were lodged javelins and brazen helmets, which had been consecrated to the goddesses of the place by Meriones and Ulysses. The town was situated in the interior of the island, to the west of Hubita.

*ENHADDAD*, a town of Judea, comprised in a part of the tribe of Issachar.

*ENHALLOW*, in *Geography*, one of the smaller Orkney islands, between Rowfa and Pomona.

*ENHANCE, To,* in *Law*, is to raise the price of goods or merchandize. See *ENGROSSING* and *FORESTALLING*.

*ENHANCED*, in *Heraldry*, a term applied to any ordinary, when removed from its usual situation, and placed higher in the field.

*ENHARMONIC GENUS*, in the *Ancient Greek Music*. The Greeks included all musical sounds in three genera or kinds of interval: the diatonic, for tones and semi-tones; the chromatic, for semi-tones and minor thirds; the enharmonic, for quarter-tones and major thirds. The scale of each genus was arranged in tetrachords, or systems of four sounds, of which the first and last were stantes, immobiles, or fixed; while the two middle sounds were termed mobiles, or changeable: and it is by these changes that the genera are distinguished.

Each of the three genera had some sounds in its scale that were peculiar and characteristic, and some that were in common with the other two. For instance, B C E F A Bb and d, were used in all the three genera, whereas D G were peculiar to the diatonic, Cx and Fx to the chromatic, and Bx Ex and Ax to the enharmonic. A complete scale of each genus in modern notes will explain this matter better than words.

The image shows three musical staves, each with a treble clef and a key signature of one flat (B-flat). The staves are labeled 'Diaton.', 'Chrom.', and 'Enhar.' on the left. Above each staff, five tetrads are indicated by brackets and labeled '1st Tetr.', '2d Tetr.', '3d Tetr.', '4th Tetr.', and '5th Tetr.'. The notes in each tetrad are as follows:

- Diaton.:** 1st: C, D, E, F; 2nd: G, A, B, C; 3rd: D, E, F, G; 4th: A, B, C, D; 5th: E, F, G, A.
- Chrom.:** 1st: C, D, E, F; 2nd: G, A, B, C; 3rd: D, E, F, G; 4th: A, B, C, D; 5th: E, F, G, A.
- Enhar.:** 1st: C, D, E, F; 2nd: G, A, B, C; 3rd: D, E, F, G; 4th: A, B, C, D; 5th: E, F, G, A.

This subject will be further pursued under the articles *Ancient Greek Music*, *GENERA*, and *TETRACHORDS*.

As modern melody is built upon harmony, derived from the harmonics of a fundamental-base, we have no instruments with quarter-tones, or which can furnish a base to an enharmonic melody, if we had the power of framing and executing it with the voice or violin. We have, therefore, only two genera in our music, with all our refinements in melody of nominal enharmonic sharps, dieses, double flats, and sharps, &c.: which two genera, the diatonic, consisting of five tones and two semi-tones in the octave, such as the key of C natural supplies upon keyed instruments; and the chromatic, consisting entirely of semi-tones, twelve in number, such as moving from any given note to its octave by semi-tones will furnish. See *TONE*, *SEMI-TONE*, and *Enharmonic SHARPS* or *DIESES*.

*ENHARMONIC Diesis*, is an interval whose ratio is  $\frac{125}{128} = 21\Sigma + 2m$ . See *Enharmonic DIESES*.

*ENHARMONIC Degree of Aristoxenus*, otherwise his diesis quadrantal, was a quarter of the major tone, or  $26\Sigma + \frac{1}{2}f + 2\frac{1}{2}m$ .

*ENHARMONIC Degree of Euclid*, otherwise his diesis quadrantal, was three-thirtieths of a minor fourth, or  $25\frac{2}{3}\Sigma + \frac{1}{2}f + 2\frac{1}{2}m$ .

*ENHARMONIC Ditone of Euclid*, was twenty-four thirtieths of a minor fourth, or  $203\frac{1}{3}\Sigma + 4f + 17\frac{2}{3}m$ .

*ENHARMONIC Quarter of a tone*, is the same with *enharmonic diesis*, above.

*ENHYDRI*, in *Chemistry*, are small nodules of chalcidony, each containing a drop of water, which are found in the porous trap of the picentine. They are often polished and set in rings, rather as an object of curiosity than of much beauty; and after a time the water usually disappears by evaporation.

*ENHYDRIA*, in *Ancient Geography*, a town of Phœnicia, between Caranus and Marathus. Strabo.

*ENHYDRIS*, the ancient Greek name for the otter.

*ENJEDIM, GEORGE*, in *Biography*, a learned Unitarian divine, who flourished in the 16th century, was a native of Hungary, whence he removed to Transylvania, where he became a superintendant of the Unitarian churches. He died in the year 1597, and was regarded as one of the best writers in what is called the Socinian cause. His principal work was entitled "Explicatio Locorum Scripturæ

Veteris et Novi Testamenti, ex quibus Dogma Trinitatis stabiliri solet," 4to. The first impression of this work was burnt by the orthodox, but a new edition was afterwards published in the Netherlands. Moreri.

*ENIF*, in *Astronomy*, a fixed star of the third magnitude, in Pegasus's mouth.

*ENIGMA*. See *ÆNIGMA*.

*ENIMIE, SAINTE*, in *Geography*, a small town of France, in the department of Lozere, 12 miles S.W. of Mende, in a country formerly known by the name of le Gévaudan.

*ENINGIA*, in *Ancient Geography*, a country or island in the north of Europe, in the Serius Codanus or Baltic sea, according to Pliny; supposed by some to be Finland.

*ENIPEUS*, or *ENIPE*, a river of Greece, in Triphylia, which ran W. of Heraclea. In the time of Strabo, it was called *Barnichius*.

*ENIPPA*, or *AGONIPPA*, a mountain of Greece, in Bœotia.

*ENISEI* and *ENISEISK*. See *YENISEI* and *YENISEISK*.

*ENISIPIA*, an island of the Mediterranean sea, near Egypt, called *Ænesippa* by Ptolemy, and *Enesipasta* by Strabo.

*ENISPA*, a town of the Peloponnesus, in Arcadia, called *Enispa* by Seneca the tragedian.

*ENIX*, in *Geography*, a town of Spain, in the province of Grenada; 8 miles W. of Almeria.

*ENIXUM SAL*, in *Chemistry*, is the sulphat of potash remaining after the preparation of nitrous acid. It is pure, if only nitre and sulphuric acid have been made use of: but as the manufacturers of aquafortis usually employ green vitriol instead of sulphuric acid, the residual salt is much mixed with colcothar or oxyd of iron; from which, however, it may be separated by subsequent solution and crystallization.

*ENKIANTHUS*, in *Botany*, from *εγκυος*, pregnant, and *ανθος*, a flower, "because," says Loureiro, "its flowers are pregnant with others." Loureir. Cochinch. 276. Clais and order, *Decandria Monogynia*. Nat. Ord. —.

Gen. Ch. *Common Cal.* of six roundish, concave, pointed, coloured leaves. *Common Cor.* of eight oblong, flat, spreading petals, containing five florets, on long reflexed stalks.

*Perianth* of five small, permanent, acute, coloured leaves. *Cor. proper* of one petal, bell-shaped; tube wide; limb short, in five rounded segments. *Stam.* Filaments ten, awl-shaped, tumid at the base, hairy, attached to the bottom of the corolla, and shorter than its limb; anthers ovate, incumbent. *Pist.* Germen five-sided, superior; style thick, as long as the stamens; stigma simple, coloured, shining. *Peric.* Berry ovate-oblong, five-sided, of five cells. *Seeds* numerous, oblong, small. *Loureiro.*

Eff. Ch. Common Calyx to several flowers; proper one inferior, of five leaves. Corolla bell-shaped, five-cleft. Berry of five cells, with many seeds.

The species are two.

1. *E. quinqueflora.* "Calyx containing five flowers. Stem arboreous." Tsiu tsung hōa of the Chinese. Cultivated at Canton. Its branches laden with red flowers, before the leaves expand, are kept for several days in china vases of water among the opulent Chinese, and are very ornamental, though destitute of scent. The tree is of a middle size, with a smooth bark, and spreading branches. Leaves crowded, oblong, pointed, entire, smooth. Flower solitary, of a beautiful red, crowned with a white fringe, and containing five florets within.

2. *E. biflora.* "Calyx containing two flowers. Stem shrubby." Sāu liēo hōa of the Chinese. Native of Canton. A shrub three feet high, with spreading branches. Leaves lanceolate-ovate, entire, hairy, small, crowded, with short footstalks. Flowers scarlet, terminal, crowded, sessile. Common Calyx of five coloured, ovate, concave, deciduous leaves. Common Corolla none. Florets two in each common calyx. *Perianth* small, deeply five-cleft; its segments lanceolate, hairy, spreading. *Cor.* bell-shaped, spreading; tube with five furrows or plaits; limb in five deep, ovate, large segments. *Filaments* ten, thread-shaped, erect, unequal, rather shorter than the corolla, inserted into the receptacle; anthers ovate, incumbent. *Germen* ovate, very hairy; style thread-shaped, longer than the corolla; stigma thickish, five-cleft, gaping. *Berry?* (not seen ripe), ovate, with five cells and many very small roundish seeds.

The above is Loureiro's account of the genus in question, concerning which we confess ourselves unable to form any decided opinion. His description of the second species is a little at variance with the generic characters, and what he every where terms a common calyx and common corolla must of course be bracteas. Some particulars indicate a plant of the *Arbutus* or *Vaccinium* tribe, but others disagree. Ornamental scarlet flowers, so well known at Canton, must long ago have been introduced to the acquaintance of European botanists. This is one of those botanical enigmas with which the good father Loureiro's book abounds, in consequence of his having studied almost entirely without communication with other botanists. Hence he took the *Hydrangea* for a *Primula*, and made a new genus of *Argemone mexicana*. See *ECHTRUS*.

ENKIOPING, or ENDKIOPING, in *Geography*, a small town of Sweden, situated on a river close to an inlet of the lake Mæler, and consisting chiefly of wooden houses painted red. It stands on a ridge of ground composed of sand and gravel, which once formed the shore of the lake; 21 miles S.W. of Upsal.

ENKIRCH, a town of Germany, in the circle of the Upper Rhine, and county of Sponheim; 3 miles N. of Traarbach.

ENKUSEN, a town of the island of Borneo.

ENLARGE, in the *Manege*, is used for making a horse go large, that is, making him embrace more ground than he before covered. This is done when a horse works upon

a round, or upon volts, and approaches too near the centre, so that it is desired he should gain more ground, or take a greater compass. To enlarge your horse, you should prick him with both heels, or aid him with the calves of your legs, and bear your hand outwards. If your horse narrows, he is enlarged with pricking him with the inner heel, and sustaining him with the outer leg, in order to press him forwards, and make his shoulders go. Upon such occasions the riding-masters cry only large, large. See *IN*.

ENLARGER L'ESTATE, in *Law*. See *RELEASE*.

ENLARGING STATUTE. See *STATUTE*.

ENMANCHE', in *Heraldry*, is when a chief has two lines drawn from the middle of the upper edge, to the sides, the depth of half the chief; the two lines including an obtuse angle, whose vertex is the centre of the top of the chief.

The heralds conceive this, as bearing some resemblance to sleeves; whence the etymology of the word, from the French *manche*, sleeve. It differs from *chappe*, where the lines come from the top to the bottom of the chief.

ENNA, in *Ancient Geography*, now *Castro Giovani*, a city of Sicily, situated on an eminence in the middle of the island, whence, according to Diodorus, it was called the "navel of Sicily." It was one of the strongest places in the island, and remarkable for its beautiful plains, fruitful soil, and the numerous lakes and springs which watered its territory; and the waters of which were highly commended for their limpidity and salubrity. Diodorus informs us, that Ceres was born in this district; and that she first taught the inhabitants of Enna the art of agriculture. He adds, that the rape of Proserpine by Pluto happened near Enna, while the young goddess was gathering flowers in a neighbouring meadow. The Enneans shewed a large cavern, which, as they believed, opened of itself, to make the god a way to his infernal kingdom. Hence originated the worship which the Sicilians paid to these two divinities; the magnificent temple which Gelo erected to Ceres in this city; and the solemn festival, which the Syracusians annually celebrated near the fountain Cyane, supposed to have sprung up when the earth opened under Pluto's feet. The temple of Ceres was famous and resorted to from all parts of Italy, Greece, and Asia, and was deemed one of the richest in Italy.

ENNEACHORD, in *Ancient Music*, an instrument with nine strings.

ENNEACRUNOS, q. d. the nine fountains, in *Ancient Geography*, a fountain of Greece- in Attica, at the foot of mount Hymettus, the waters of which were conveyed through nine pipes or channels into the town, constructed by order of Pisistratus.

ENNEACTIS, in *Natural History*, a name given by Linkius to a sort of star-fish, of the more branched or astrophyte kind, which has only nine rays, where they first part from the body, but these divide into a vast number of others afterwards.

ENNEADECATERIS, in *Chronology*, a cycle, or period, of nineteen solar years.

The word is formed of *ennea*, nine; *deka*, ten; and *eros*, year.

Such is the lunar cycle invented by Meton, at the end whereof the moon returns nearly to the same point from which it departed. Whence the Jews, Athenians, and other nations, who were disposed to accommodate the lunar months to the solar years, made use of the enneadecateris; allowing to the year of the years thirteen months apiece, and to the rest twelve. See *CYCLE*, and *EMBOLISMIC*.

ENNEADECATERIS, the Jewish, is properly a cycle of 19 lunar

lunar years, beginning from *molad tohu*, and returning again and again; whereof every 3d, 6th, 8th, 11th, 14th, 17th, and 19th, are embolismic, or of 383 days 21 hours apiece; the rest common, or of 354 days 8 hours apiece. See YEAR.—Consequently, the Jewish enneadecateris is 6930 days 18 hours.

ENNEAGON, in *Geometry*, a figure of nine angles, and nine sides.

The word is formed of *εννεα*, nine; and *γωνια*, angle.

ENNEAGON, in *Fortification*, denotes a place with nine bastions. See FORTIFIED PLACE.

ENNEAHEDRIA, derived from the Greek *εννεα*, nine, and *ειδης*, a side, in *Natural History*, the name of a genus of spars.

The bodies of this genus are spars, composed of nine planes, in a trigonal column, terminated at each end by a trigonal pyramid. Of this genus there are four known species. Hill's *Hist. of Foss.* p. 208.

ENNEANDRIA, in *Botany*, from *εννεα*, nine, and *ανδρ*, a man, the ninth class of the sexual or artificial system of Linnæus, consisting of plants with nine separate or distinct stamens in the same flower with the pistil or pistils. It contains three orders, *Monogynia*, of which the valuable genus *Laurus*, including the Cinnamon, Cassia, one sort of Camphor, Sweet Bay, &c. is an example, and there are some other fine plants in this order; *Trigynia*, of which *Rheum* or Rhubarb, nearly allied to *Rumex*, is the only instance, and *Hexagynia*, consisting of *Butumus umbellatus* alone. Hence it appears that nine is an unusual number in the parts of flowers, though not quite so uncommon as seven.

ENNEAPYRGÆ, in *Ancient Geography*, a town of Greece, in Attica, 7 or 8 leagues from the promontory of Sunium.

ENNEATICAL DAYS are every ninth day of a sickness; which, some imagine, naturally occasion a great alteration, either for the better or worse.

ENNEATICAL Years are every ninth year of a man's life. See CLIMACTERIC.

ENNEBACKA, in *Geography*, a town of Norway; 26 miles S.E. of Christiania.

ENNEEMIMERIS is one kind of the cæsura of a Latin verse, where, after the fourth foot, there is an odd syllable ending a word, which helps to make the next foot with the following word; as in this instance,

“ Ille latus niveum molli fultus hyacintho,”

where all the four kinds of the cæsura occur.

ENNEL LOUGH, in *Geography*, a lake of the county of Westmeath, Ireland, near Mullengar.

ENNEOPHTHALMOS, from *εννεα*, nine, and *οφθαλμος*, eye, in *Zoology*, a name given by some to the lampræy.

ENNERIS, in the *Ancient Ship-Building*, a name given to those galleys, or vessels, which had nine tiers of rowers. These were of a very considerable size; though Meibom has found for convenient a method of placing the rowers that he has taken off very much from that immense height others supposed they had above the water. We read of the tessaracontes, and other amazing vessels of this fabric; and that of Philopater having forty rows of oars, and that of Ptolemy Philadelphus, thirty; and some others which are spoken of, twenty. It has been disputed by many, whether such large vessels as these were ever actually built, or used; but Meibom gives great reason to believe that they really were, though he, at the same time, alleges against Salmasius, and the more sanguine admirers of the works of the ancients, that very few vessels were built larger than these

enneres, or nine tiered ones, and proves it from Livy and Plutarch, and from Polybius. We are apt to admire, in many cases, what we ought also to imitate, but never attempt it. This is the case in these galleys; and Meibom, who has given the rules of this ancient naval architecture, is of opinion, that by imitating it at present, modern galleys and galleasses might be built much more conveniently both for strength and celerity, and also at less expence, than they are at present. Meibom. de Trirem.

The modern form is indeed allowed to be better than theirs; but if in the structure, the proportion of the long ships of the ancients were observed, they might be greatly improved: in the modern way of five men sitting at one oar in the galleasses, much strength is wasted to no purpose, because they sit too near to the fulcrum, or stay, whereas a smaller number of rowers, at a greater distance from the stay, would give more strength, and throw the vessel along much more swiftly, and would require less charge. Galleys of this sort, thus managed at a small expence, would be found of great use in the large rivers, and in the shallow seas, and therefore convenient for the Baltic, the Britannic, and the Mediterranean seas, and would be the most useful of all vessels for transporting great numbers of forces.

ENNEZAT, in *Geography*, a small town of France, in the department of the Puy de Dôme, chief place of a canton in the district of Riom, with a population of 2393 individuals. The canton contains 8 communes and 9168 inhabitants, on a territorial extent of 142½ kilometres.

ENNIS, a post-town in the county of Clare, Ireland, of which it is the capital. It is large and populous, and has the advantage of a small port at Clare, which is situated a few miles lower on the river Fergus; the tide bringing up large boats thence to Ennis. There are at this town the remains of one of the finest abbey-churches in Ireland, built in an elegant style of Gothic architecture. It is a borough town, and sends one member to the united parliament. It is 112½ Irish miles S.W. by W. from Dublin, and 17 N. by W. from Limerick. W. long. 8° 54'. N. lat. 52° 49'.

ENNISCORTHY, a post-town of the county of Wexford, Ireland. It is situated on the river Slaney, which is navigable for small sloops to this town. Its situation is agreeable and picturesque; and there are the remains of a considerable castle built by the first English settlers. It is the estate of the earl of Portsmouth. Enniscorthy has a manufacture of coarse woollen-cloth, and is a thriving town. Near it are lead mines, which are very productive. Vinegar-hill, near this town, was a strong hold of the insurgents in 1798; and the loyal inhabitants were great sufferers at that eventful period. Enniscorthy was represented in parliament before the union. It is 60 miles S. from Dublin, and near 12 N. from Wexford.

ENNISKILLEN, a post-town of the county of Fermangh, Ireland, and the place where the assizes are held. It is built in an island, formed by the river which unites the two lakes, and is the single pass of communication between the parts of the county which these waters separate. The strength of its situation pointed it out as a military post; and when the adherents of James II. excited a just alarm throughout the country, numbers flocked to this place, where they bravely resisted a much superior force, and even gained several important victories. These valiant men were formed into a regiment, which rendered effectual service to king William; and to this day the 27th regiment glories in the name of the *Enniskillers*. There is a school here, founded by James I. on the plantation of Ulster, the income of which, by the great rise in the value of lands, has become very considerable. Enniskillen returns one member

to the imperial parliament. Distance from Dublin N.W. 79 miles.

**ENNISTYMOND**, or **INNISTYMOND**, a small post-town of the county of Clare, Ireland; situated 118 miles W. by S. from Dublin, and 13 W. from Ennis.

**ENNIUS**, **QUINTUS**, in *Biography*, an ancient poet, was born at Rudia, a city of Calabria, near Tarentum, about the year of Rome 514, B. C. 237, and flourished about the close of the first Punic war. According to Silius Italicus, he served as a centurion in Sardinia, when that island was subdued by T. Manlius, and distinguished himself by his valour. After the war he probably remained in Sardinia; for Cornelius Nepos informs us, that Cato, the censor, when prætor, brought back with him from his government of Sardinia, the poet Ennius, who must at this time have been in his 35th year. Another of his patrons was Scipio Africanus the elder, who made him his companion in most of his campaigns. This fact we learn from Claudian. He was also intimate with Scipio Nafica. The notice taken of him by these eminent persons affords favourable testimony to his general character and manners; although Horacé (Epist. xix. l. 1.) represents him as warming his heroic vein by liberal potations. The gout, with which he was afflicted, and his depressed circumstances, were probably owing to his intemperance. These evils, however, he bore with great equanimity; and his life was prolonged to the age of 70. He is said to have been the father of epic or heroic poetry among the Latins, though the Greek was his mother-tongue. He was distinguished by that rustic vigour, which is the usual characteristic of genius in an unpolished age. Thus Ovid represents him;

“Ennius ingenio maximus, arte rudis.”

Lucretius mentions his having first brought the muse to Latium; and Virgil has transferred into his works many whole or half lines from Ennius, thus testifying his esteem of him. The events of Roman history formed the leading subjects of a large performance entitled “Annals,” subsequently divided into eighteen books. On certain days he was accustomed to recite portions of this poem. He also composed tragedies, comedies, epigrams, and satires; and also some didactic works. By his life of Scipio Africanus, he engaged the affection of the Cornelian family, who manifested their gratitude to him even after his death, depositing his ashes in the same tomb with those of Scipio, and erecting a marble statue to him near that of this great commander. The poet Nævius, who was his contemporary, after having made some campaigns in the first Punic war, wrote the history of that war in verse, according to the taste of those times. Fragments only of the works of Ennius remain; these have been published separately, Amst. 4to. 1707, and also in Mattaire’s *Corpus Poetarum*.

**ENNODIUS**, **MAGNUS FELIX**, bishop of Pavia in the sixth century, was born of illustrious parents about the year 473. His education and maintenance devolved upon an aunt, by whose death, before he was sixteen years of age, he was reduced to distressing circumstances, but afterwards, by a fortunate marriage, he attained to a state of affluence. Notwithstanding this union, he had a strong inclination for the ecclesiastical profession, and obtained his wife’s consent to enter into holy orders, whilst she at the same time embraced a religious life. He was ordained a deacon by Epiphanius, bishop of Pavia, with whom he lived in habits of the strictest intimacy and friendship. He had an early taste for literature, which he cultivated in connection with his theological studies, with so much success as obtained for him the reputation of an ex-

cellent scholar. On the death of his friend Epiphanius, he was admitted among the deacons of the church of Rome, and for some services done for the popes and church, he was promoted to the see of Pavia about the year 510, and appointed on the commission for negotiating a re-union between the eastern and the western churches. The only reward for his services in this respect, was drawing down upon his head the resentment of the emperor Anastasius, who, after much ill treatment, dismissed him home in a shattered vessel, with a strict prohibition of never again landing at any port in Greece, by which his life was exposed to the most imminent danger. He arrived safe in Italy, but died as he was on his journey to Pavia, in the 48th year of his age. His works are numerous, and have been frequently printed; they were published, with many useful explanatory notes, at Paris, in the year 1611. Mofheim *Ecel. Hist.* Moreri.

**ENNUI**, a French term which is sometimes used to denote a kind of littlefness or unaptness for mental exertion; or which may be more scientifically defined to mean the uneasiness that prevails during the absence of mental impressions. The aversion from *ennui*, or the desire of intellectual emotion, is described by Helvetius, in his work “On Mind,” as a very powerful and general spring of conduct, and he ascribes to this law of the mind, perhaps, a greater degree of influence than that which properly belongs to it, conformably to the avowed sentiments of a writer, who maintains that “to judge is to feel,” (*juger c’est sentir.*)

**ENO**, in *Geography*, a town of European Turkey, in the province of Romania; the see of a Greek archbishop; 28 miles N.W. of Gallipoli.—Also, a river of America, in North Carolina, which unites with Little and Flat rivers in Orange county, and forms the Negus, about 17 miles below Hillsborough.

**ENOCH**, in *Biography*, the son of Jared and father of Methuselah, was the seventh in lineal descent from Adam, and born in the year B. C. 3382. Eminently distinguished by his piety and virtue in a corrupt age, he was translated to heaven in the 365th year of his age, without undergoing the pains of dissolution. An apocryphal book, entitled “The Book or Prophecies of Enoch,” has been ascribed to this celebrated antediluvian, and is cited, as some say, by Jude in his epistle, and more certainly by Irenæus, Clement of Alexandria, and other ancient fathers. But this book was probably forged in the second century. The Mahometans mention Enoch under the appellation of Edris, or Idris, and record many fables concerning him, which it is needless to mention.

**ENOCH**, in *Ancient Geography*, a city said to have been built by Cain in the land of Nod, where he and his family settled, and called after the name of his son Enoch. (Gen. iv. 16, 17.) Moses places it, according to our translation, on the east of Eden; and Ptolemy mentions a city called Anuchtha in Susiana, or Chusistan, a country lying eastward from Chaldæa, which the learned Huet supposes to have been the same with that built by Cain. But it seems very improbable, that the city of Enoch, built before the flood, should either withstand the deluge or retain its ancient name, after so great a change in the surface of the earth. Besides, Susiana being a very fertile and pleasant country, it is not likely that Cain should be banished thither, but rather to some barren and desolate land, remote from the place of his nativity, and separated by mountains, or other natural impediments, from intercourse with his relations. As there was another Enoch (see the preceding article) besides the son of Cain, it is not improbable that the city Anuchtha mentioned by Ptolemy, might have taken its name from him, whose memory would be held in veneration,

or from some other Enoch or Anoch, who might have lived after the flood. Grotius and Junius are of opinion, that the country into which Cain retired was the desert of Arabia; but as this country lies on the west, and not on the east of Eden, it is said, that the words which we translate "on the east" of Eden signify no more than "before" or "over-against" Eden, according to the translation of the Septuagint. According to this opinion; the land of Nod must have been Arabia Deserta, or some part of it, and not Sufiana. Wells's Geog. vol. i.

ENODIS, *CULMUS*, in *Botany*, a culm or straw destitute of any knot, joint, or prominent transverse interruption. See *CULMUS*.

ENOLA, in *Geography*, a town of Naples, in the province of Lavoura; 4 miles N. of Fundi.

ENOLMIS, *Ενολμις*, in *Antiquity*, a designation given to Apollo's priests at Delphi, because the fat on the tripod which was called olmos, *ολμος*. Hence also Apollo is called Enolmos, *Ενολμοις*. Pott. Archæol. Græc. lib. ii. cap. 9. tom. i. p. 275.

ENOMTEKIR, in *Geography*, a town of Swedish Lapland; 150 miles N. of Tornea.

ENON, in *Ancient Geography*, a place of Judea, situated near Jordan in the half-tribe of Manassch; which was the place in which John baptized, (John iii. 23.) because there was abundance of water. This place was between Shalim and Jordan, about 8 miles from Scythopolis.

ENOPA, a town of the Peloponnesus, in Messenia, situated on an eminence at a small distance N. of Cardamyla.

ENORAINE, in the *Manege*, a wither-wrung horse, or one that is spoiled in the withers. The word is obsolete.

ENORCHIS, in *Natural History*, the name given by many authors, to that species of ætites, or eagle-stone, in which the callimus, or internal nucleus, is not loose, so as to rattle in it when shaken, but remains fixed to one side. The Germans call this *hodenstein*. The outer crust is usually of a whitish colour, and the internal nucleus is yellowish or brownish, and it is usually of the size of a pigeon's egg, and of the shape of the human testicle; whence the name.

ENORMOUS, something excessive, or monstrous, especially in bulk. The colossus of Rhodes was of an enormous stature.

The word is formed of the privative *e*, and *norma*, rule; *q. d. void of, or contrary to, rule or measure; contra normam*. In the corrupt ages of Latinity, they used *innormis*, and *inormis*.

In the French jurisprudence, *leso enormis*, enormous damage, is that which exceeds half the value of the thing sold.

ENOTAEVSK, in *Geography*, a town of Russia, in the government of Caucasus, on the Volga; 72 miles N.N.E. of Astrachan.

ENOUREA, in *Botany*, (a barbarous name, from the Caribæan word *Enourou*.) Aublet Guian. v. 1. 587. t. 235. Juss. 249. The only species is *E. capreolata*, a climbing shrub, with something of the habit of a *Paullinia*, furnished with circularly-turned tendrils, pinnated leaves, spiked flowers, and a remarkable globular capsule of three valves, containing a globular seed imbedded in farinaceous pulp. Jussieu has copied its characters from Aublet, but Schreber has passed it by.

ENQUEST, or INQUEST, in *Law*, denotes an inquiry of a jury by hearing of witnesses.

This is the most usual manner of trial, in all causes, both civil and criminal, within this realm. In civil causes, after proof is made, on either side, of so much as each

party thinks good for himself; if the doubt be in the effect, it is referred to the discretion of twelve indifferent men, impanelled by the sheriff for that purpose; and as they bring in their verdict, so judgment passeth: for the judge saith, *the jury findeth the fact thus*. See WRIT of *Enquiry*. For the enquest in criminal causes, see JURY.

ENRICHED COLUMN. See COLUMN.

ENRICHING PLANTS, a term used, by the English farmers, to express such plants as are found to do good to land, rather than to exhaust it, and in consequence of which the same piece of land will produce a good crop of corn, though it would, without the assistance of their having been planted on it, have yielded a very poor one. The mystery of this difference between plants, some of which are found to burn up, that is, impoverish lands, while others enrich it, and leave it fitter for succeeding crops than they found it, is explained by Mr. Tull. This author having observed, that breaking the earth, by digging, or horse-hoeing, between the plants, gave them great increase, found that it was this practice that enriched the earth: and that, while corn and such plants as stand close, and cannot be hoed between, impoverish the ground, and suffer no means of enriching it again to be used, there were some other things, the crops of which being planted thinner, gave room to the earth to be ploughed, dug, or hoed between, and that these were the plants which were called the enriching kind by the farmers; and the whole secret lay in this, that the hoeing, ploughing, or otherways breaking the earth between them, in order to kill the weeds, enriched the ground greatly more, in proportion, than these plants exhausted it; and the consequence was, that though they had thriven very well, yet the earth was left richer than before, notwithstanding all that they had imbibed from it. Tull's Horsehoeing Husbandry, p. 37.

On this observation, this excellent author seems to have founded the system of what he calls horse-hoeing husbandry, concerning which he has written a large and useful treatise. He found that this stirring up of the earth enriched it so greatly, that, where it was used in a proper manner, the kind of plant need not be changed, but that the same earth would yield a successive series of crops of the same plant, and that even without dunging, or ever lying fallow, and every crop, for a long time, would be better than the former ones. The method of sowing, to this purpose, is not by scattering the corn with the hand, but sowing it in rows, and leaving large intervals between, the naked earth of which might be turned up by the hoe. See ALLEY and HOEING.

ENROL, in *Military Matters*, signifies the registering of such persons as, being enlisted, or appointed, are placed upon the rolls, or strength, of any particular regiment, troop, company, or portion of the military establishment. The act of enrolment seems to be held necessary in proof of a soldier's having become a servant of the state; equally so with the circumstance of his having received pay, or some money, however trifling, in advance. For it does not appear reasonable, that a soldier should be punished for absenting himself from that employ in which he has not received either pay, or subsistence. It is not, however, to be understood, that, after being duly enlisted in the presence of a magistrate, the recruit is at liberty to quit the party by whom he has been entertained: far otherwise; for though we hold a decided opinion regarding the devices often practised, to ensnare young men from their homes and families, we consider it indispensable that the sacred engagement should remain purely inviolate, after being once legally acknowledged.

knowledge by the party to be enrolled. See **INLIST** and **ENTERTAIN**.

In registering, that is to say in enrolling, a recruit, it is usual to be very exact in ascertaining the place of his nativity, his religion or sect, his age, his state of health, especially whether he be subject to fits, or be ruptured; while, for the purpose of apprehending him in case of desertion, his height, complexion, general figure, the colour of his hair, and of his eyes, together with any particular distinguishing marks, whether natural or accidental, are all noted; comprising, in the aggregate, what is called "description roll," of which a transcript is sent with each soldier, whenever draughted from one company or regiment to another.

Although a recruit is bound to the service after being examined and deemed competent to serve, by the inspecting surgeon, and the supervisor of the recruiting service of the district respectively, and after having acknowledged his being duly enlisted in presence of a magistrate, by whom the oath of allegiance should be tendered as conveniently might admit, he is not said to be enrolled until he is efficiently placed upon some list, whether under the recruiting officers, or in any particular regiment, troop, or company. In some instances, especially in the service of the East India Company, the whole of the recruits are lodged at a general depot, under the charge of officers fixed thereat, but without being attached to any particular regiments until their arrival in India: in the mean while they are formed into squads, under the immediate controul of non-commissioned officers, by whom they are trained in the rudiments of military discipline. We cannot with strict propriety say, that such men are enrolled; nor, indeed, do we hold the term to be applicable until they are in a certain degree fixed in some particular company, and entered upon its muster-roll, as well as upon the long-roll of the regiment.

**ENROLLMENT**. See **INROLLMENT**.

*Clerk of the ENROLLMENT of fines*. See **CLERK of the Inrollments**.

**ENS**, in Latin *Anisfa*, *Anasum*, or *Ensia*, in *Geography*, a town of Aultria, in the province called Upper Aultria, or the country above the Ens, in the district of Traun. It is situated on an eminence in the river Ens, which, not far from this place, falls into the Danube, 15 miles S. E. of Lintz, and 108 miles W. of Vienna. N. lat. 48° 11'. Its origin dates from the year 900, and it is built on the same spot where stood the Laureacum of the Romans, one of their colonies, which was destroyed by the Huns about the year 450. Ens is strongly fortified; its citadel is called *Enseck*, or the corner of Ens.

**ENS**, in Latin *Anisus*, or *Anasus*, a river of Germany, which has its source in the mountains of the former bishopric, now grand duchy of Salzburg, flows through Upper Aultria, and falls into the Danube near the town of Ens.

**ENS**, *Entity*, *Being*, in *Metaphysics*, is applied, in a general sense, to every thing which the mind any way apprehends, and whereof it affirms, denies, proves, or disproves, any thing. This other philosophers call cogitable, and intelligible; and the logicians, *thema*.

**ENS**, in a less general sense, signifies something that is, or exists, some way farther than by being conceived, or being capable of being conceived, in the mind. This is particularly called *ens positivum*, or *reale*; *positive*, or *real*, being. In opposition to which stands *non ens*.

**ENS**, in its proper, or restrained sense, is that to which there are real attributes belonging, or that which has a reality, not only out of the intellect, but in itself. This is what is properly meant by *res*, *thing*; and what we otherwise call *ens reale*, and also *substance*.

**ENS rationis**, is that which depends wholly on the mind, or which exists only in the imagination: of which they distinguish three kinds: *ens rationis affectivum*, which is done or produced by the mind, as knowledge; *ens rationis subiectivum*, which is received into the mind, as science; and *ens rationis objectivum*, which is represented by the mind, as a chimera, a golden mountain, or the like. Which last, if it have no other manner of being, i. e. if it be presented so as it does not, or cannot be, is what we most properly call *ens rationis*. The generality of school philosophers, and the Peripatetics among the rest, assert, that there are of these *entia rationis objectiva*. Others deny there are, or can be, any such things.

**ENS**, or **ENS primum**, in the *Ancient Chemistry*, denotes the most efficacious part of any natural mixed body, whether animal, vegetable, or fossile, wherein all the qualities or virtues of the ingredients of the mixed are comprehended in a small compass.

Paracelsus pretends to have been able to separate the *ens primum* from bodies, and with it to effect prodigious things towards the renovation and restoration of youth; but his processes are so obscurely delivered, that no body has been induced to try them.

**ENS primum salum**, a name given by Paracelsus to a preparation of sea salt, which he calls also a perpetual oil, and *sal circulatum*, which see.

**ENS martis**, and **ENS veneris**. If the filings of iron or of copper be mixed with sal ammoniac and strongly heated, a decomposition, greater or less in proportion to the quantity of metal employed, will take place: the ammonia will be liberated in the form of gas, while the muriatic acid will combine with the metal. The metallic muriat thus formed will sublime at nearly the same heat as the undecomposed residue of the salt, whence will result an accurate mixture of the two in the form of flowers, or a crust of a red colour: if iron filings have been used, and of a green colour if copper has been employed. The former of these is *ens martis*, the latter, *ens veneris*.

**ENSATÆ**, in *Botany*, from *ensis* a sword, alluding to their sword-shaped leaves, a name very happily applied by Mr. Gawler to the natural order of *Irides* of Jussieu, it being desirable that, if possible, every natural order should have an expressive name, independent of any particular genus it may contain; or at least that its name should not be a mere unchanged repetition of that of any such genus. This order is illustrated by the able botanist above-mentioned, in Sims and König's *Annals of Botany*, v. i. 219, and especially in Curtis's *Botanical Magazine*.

**ENSCONCED**, in the *Military Art*. See **INSCONCED**.

**ENSEELED**, in *Falconry*, a term used for a hawk which has a thread-drawn through her upper eyelids, and made fast under her beak, to obscure her sight.

**ENSEINT**, in *Law*, a term used to denote a pregnant woman.

**ENSEMBLE**, a French term, sometimes used in our language, literally signifying *together*, or *one with another*; being formed from the Latin, *in*, and *simul*.

In *Architecture*, we say, the *ensemble*, or *tout ensemble* of a building; meaning the work or composition, considered together, and not in parts; and sometimes also the relative proportion of the parts to the whole. All those pieces of building make a fine *ensemble*.

To judge well of a statue, or other work of sculpture, one must first examine whether the *ensemble* be good.

The *tout ensemble* of a painting, is that harmony which results from the distribution of the several objects of figures whereof:

whereof the whole is composed. This picture is good, taking the parts separately: but the tout ensemble is bad.

**ENSEMBLE, Fr.** together. This adverb, used substantively, and received in the French musical technica, is, according to Rousseau, invested with a very extensive signification. To regard an object in its ensemble or totality, is to consider the effect which the several parts produce, when united in a whole.

It is only in the execution of a piece of music, that this term is applicable, when the performers are so perfectly together in time and tune, seeming to be all so much animated by one soul, that they communicate exactly to the ear, all that the eye can see in the score.

The being together does not merely depend on the accuracy with which each reads his part, but in the intelligence with which he feels its peculiar character and connection with the whole; whether in the exactitude of phraseology, the precision of the movements, or seizing the instant and degree of pianos and fortes; or finally in the nice attention to such ornaments, which the author has thought so necessary as to be indispensable. It is in vain for musicians to have abilities, they can never be together without an intelligence of the author's designs, and perfectly understanding each other: for it would be impossible to keep together a band of performers that are deaf, nor in the execution of music in a style with which they are totally unacquainted. It belongs to the masters, conductors, and leaders of an orchestra, to guide, check, or accelerate individual performers, and to keep them together in the aggregate, which is always the office of a judicious first violin: who, by a certain firmness and energy in his manner, strongly impresses the character of the piece in every ear. The vocal part is subordinate to the base and the time; the first violin ought to watch and follow the voice; the ripienos should listen to and be guided by the first violin: and, finally, the harpsichord or piano forte, at an opera where the composer is supposed to sit, should be the principal and most important guide of the whole. In general, the more character there is in the style, periods, phrases, melody, and harmony, the more easy it will be to seize the ensemble; because the same idea, strongly impressed on all minds, will preside in the whole execution. On the contrary, when the music says nothing, and nothing is heard but a succession of notes without meaning: then as there is no whole to which each performer can refer his part, the ensemble goes ill.

This (says M. Rousseau) was the reason why French performers could never be together.

**ENSENE'**, called also *Infiné*, *Scheick Abadè*, and by the Arabs *Enfiné*, in *Geography*, a town of Egypt, situated towards the middle of the Saïd, east of the Nile, and dependent on the province of Achmounain, which is on the other side. Abulfeda represents it as an ancient city, surrounded by a well cultivated country, abounding in fruits and harvests. But these fertile plains have disappeared with their inhabitants, and given place to sands and deserts. See **ANTINOË**.

**ENSHMESH**, i. e. *the fountain of the Sun*, a town or fountain, which lay on the frontiers of Judah and Benjamin. (Joh. xv. 7.) The Arabians give this name to the ancient metropolis of Egypt, which the Hebrews called *On*, and the Greeks *Heliopolis*.

**ENSIFORM**, in *Anatomy*, a term equivalent to xiphoid, and meaning dagger-shaped. It is applied to the cartilage placed at the lower end of the sternum. See **TRUNK**.

**ENSIFORM Leaf**, in *Botany*, a vertical two-edged leaf like a sword, as in many species of *Iris*. See **LEAF**.

**ENSIFORM Cartilage**. Dr. Hunter remarks, that, "if this cartilage be forced inwardly by a blow, it will occasion vomiting and violent pains, by pressing against the pylorus: in this case, it would be proper to lay it bare and elevate it." However, the same eminent writer admits, that as part of the diaphragm arises from the cartilage, the latter would be likely to be drawn out of its proper situation again by the action of so powerful a muscle.

**ENSIGN**, in *Military Affairs*, is an officer whose duty it is to carry the colours; hence, when a youth first obtains a commission in the infantry, he is said to "receive a pair of colours." This is the first gradation above the rank of cadet, or volunteer, but is the lowest of all the ranks in which commissions are held, and though obtainable by purchase, cannot be realized without satisfactory recommendations, and the approval of the commander of that regiment to which the nomination is to be made. From this, of course, some deviations are occasionally admitted; but the necessity for ascertaining that none but proper persons be included within the circle of commissioned officers, occasions considerable strictness to be observed in this particular; notwithstanding which, instances have occurred of men, by no means eligible to so honourable a distinction, having obtained commissions even in some of what are technically termed "crack regiments."

The duty of an ensign requires much attention, and at times some share of bodily strength; for, on a windy day, when the colours are fully displayed, a puny person might suffer considerable inconvenience; and, indeed, at all times, though supported in a sling, the colours are rather oppressive; especially to those unaccustomed to carrying them. With regard to the station of the ensign when acting with his company, or when bearing the colours, we refer to the head of **EVOLUTION**; where the various changes of locality to which this officer is subject will be exhibited.

It is proper to remark, that although there are two stands of colours to each regiment, only one of them is properly called "the ensign." The flag, consisting of the union only, is called the king's colour, and always takes post of the other, which being in general of the same colour as the facings of the corps, and bearing any device or motto, by which it is distinguished, is appropriately called "the regimental ensign."

In case of defeat, the ensigns bearing the colours must be very careful to collect as many of the fugitives as possible for the purpose of rallying the corps, or, at least, of preventing it from being further disgraced by the loss of their facings, which formerly was an inseparable consequence annexed to the loss of the colours. This regulation certainly must often produce considerable enthusiasm; and we may reasonably conclude, that the attack made by a regiment under such a privation, (which could only be remedied by its taking the colours of their opponents,) must be of the most arduous description. In truth, we find in every walk of life, that where an imputation is to be removed, considerable energy is created by the existing disgrace; and, that the most determined resolution is formed not only to remove it, but to obtain a claim to pre-eminent consideration in future.

The pay of an ensign in the Guards is five shillings and tenpence daily; in the line, only four shillings and eightpence: a sum by no means adequate to the maintenance of a young gentleman in such style as is at present too generally prevalent in almost every regiment. So far is this carried, that many young men of considerable merit are often compelled to exchange, or even to sell out; because their finances are inadequate to bearing a share in the mess expences.

expences. Nor is it unusual for a notice to be given by the agent, or other person, to the candidate for a pair of colours, that such a certain sum annually will be needful, beyond his pay, to enable his keeping on a par with his brother officers. We are credibly informed, that in some regiments it is actually impossible for an officer to associate with his peers, unless he may possess from 500 to 1000*l.* income, over and above his allowances!

When we analyse this, we cannot but consider it to be a national evil, and that too of no small extent. We are far from wishing to see the respectability of our officers, in the smallest degree, tarnished; but it certainly cannot fail to strike, even the most superficial observer, that such an excess of expence amounts nearly to a prohibition of the middling classes, and operates in the same manner, though not so avowedly, as the ancient regime of France, which proscribed all but those of noble family, or of established descents through generations devoid of mercantile speculation, from entering within the military pale. The very dress of some corps must cost so much as to preclude the possibility of moderate fortunes being admitted. What shall we say to the charges made on a young gentleman's purse, when it is stated, that in some regiments of horse, full six hundred pounds may be required to equip him as a cornet! While an equal sum per annum, will be *in requisition* (here the term seems peculiarly appropriate) to enable him to eat, drink, and appear in the same company with his brother officers. Nor is this all; for the commission may cost a large sum, such as added to the other items would form a capital wherewith the youth might purchase an annuity, far exceeding the pay he would be likely to receive, for at least ten or twelve years. We believe the Scotch regiments are no slouches in the field, and that they bear as many good characteristics as any in our service; yet their dress is generally very plain, and their fare very far from sumptuous. They are born economists; and from being brought up in a hardy, active routine, are capable of enduring great fatigue, and of putting up with various privations, which, to a person brought up with less ceremony, and habituated to the enjoyment of various luxuries, might be at least unpleasing, if not absolutely distressing.

The Turkish ensigns are horses' tails; the number of which distinguishes the rank of their commanders; the sultan has seven, the grand vizier only three, &c. Those of the Europeans are pieces of taffety, with divers figures, colours, arms, and devices, thereon. Xenophon tells us, that the ensign borne by the Persians was a golden eagle on a white flag; the Corinthians bore the winged horse, or Pegasus; the Athenians, an owl; the Messenians, the Greek letter M; the Lacedæmonians, the A.

The Romans had a great diversity of ensigns; the wolf, minotaur, horse, boar, and at length the eagle. See *SIGNA*.

A military ensign, on a medal of a Roman colony, denotes it a colony peopled with old soldiers.

*ENSIGN*, in *Naval Affairs*, is the large flag hoisted at the stern of a ship, whether of war or in the merchant service, and denotes the country to which she appertains, or the government under whose protection and authority she is navigated. Of the several distinguishing ensigns, a more ample description will be found under the head *FLAG*: we shall briefly observe in this place, that this, as well as most of the colours of ships, whether *jacks* or *pennants*, are commonly constructed of hunting, and, that it is usual to make them so ample as to occupy two-thirds of the flag-staff in height, and to give them depth enough just to touch the surface of the water, when in a quiescent state. All ensigns

are hoisted with their unions, or distinguishing cantons, uppermost, next to the truck on the head of the flag-staff: when hoisted in the shrouds with the union, or distinguishing canton, lowermost, so as to reverse all the figures, decorations, or inscriptions, it is indicative of distress. The liberality of some nations has been conspicuous in forbearing from making prizes of vessels so circumstanced, provided their commanders have engaged to return to the nearest port, without intermediately offering any violence to such as they might meet, there to remain in ordinary until the conclusion of the war.

The display of an ensign in presence of a strange sail is generally considered a mark of civility during times of peace, and in times of war serves to distinguish between friends and foes. During the latter period, such vessels as do not hoist their ensigns may be reasonably suspected to be privateers, or to be desirous of evading every kind of communication. So long as the ensign remains hoisted, during an engagement, the ship is to be considered in a state of defiance; but when it is lowered, she is said to strike; that is, to give up the contest, and to submit, as a prize to her opponent. It occasionally happens that a ship's ensign staff, or the halyards by which the ensign is hoisted to the mizen-peak, is shot away; this does not indicate submission; on the contrary, the annals of warfare exhibit many instances of extraordinary courage in individuals, who, at such moments, have ran aloft, or even stood on the poop, there to sustain a portion of the ensign as a token of the most determined opposition. In the British service we have three ensigns, namely, the white, the red, and the blue; the first is divided into equal portions, by a broad St. George's cross of red, of which the upper canton, or quarter, is filled up with the union. The second and third are both plain, with the exception of the union in the same canton. These several ensigns indicate the rank of the admiral under which a ship of war is commissioned, or employed. Thus, an admiral of the white bears a white, or, as it is commonly called, a St. George's ensign, at the main top-gallant mast head; a vice admiral of the white has one at the fore top-gallant mast head; and a rear admiral one at the mizen top-gallant mast head; the same rules of precedence obtain, with the admirals, vice-admirals, and rear-admirals of the red and blue respectively; each bearing a flag of his proper colour at that mast head corresponding with his rank. When fleets are separated into squadrons or divisions, each ship assumes for the time the ensign of that admiral who commands the squadron, or division, in which it acts. The same is observed by all vessels acting under any particular port-admiral; all under his authority invariably bearing an ensign conformable to his designation, whether of the white, red, or blue.

*ENSIGNCY*, denotes the rank of that officer who bears the ensign or colours of a regiment of foot; and corresponds with that of "cornet" in the cavalry, and of "second-lieutenant" in the artillery. It is, perhaps, one among the curious anomalies which pervade many parts of our system, that an ensigncy should exist in the engineer department, there being no colours to be carried in that corps, while the colours of the artillery battalions are borne by the second lieutenants.

An ensigncy in a marching regiment may generally be obtained for about three hundred pounds, when serving within the realm: but in various situations abroad, especially in the East Indies, where an increase of pay is given, the price is usually much higher. See *ENSIGN, military*.

*ENSISHEIM*, in *Geography*, a handsome town of France, in the department of the Upper Rhine, in the district of Colmar, with a population of 1809 individuals. It

is situated on the river Ill, 12 miles N. of Mulhausen, 12 miles S.W. of Brisack, 294 miles S. by E. of Paris. N. lat. 47° 52', and is the chief place of a canton, which has a territorial extent of 257½ kilometres, 17 communes, and 10,122 inhabitants.

ENSTASIS, *Ἐνστάσις*, of *εν* and *ἵστημι*, *statio*, in *Logic*, a manner of replying to an opponent, either by confuting his argument, or denying the justness of his conclusion. Voff. Rhet. lib. iii. p. 380.

ENSTASIS, in *Medicine*, a term used to express the ingress of molecule into the vacuity of the pores which obstruct them, and thereby cause diseases. It is a word familiar with Erasistratus and Asclepiades, who was a follower of Democritus, and taught that most diseases were caused by such an ingress of matter into the pores. Thus Asclepiades defined a phrenzy to be such an entasis in the membranes of the brain. Plutarch, in his precepts of Health, also mentions this entasis: and Galen and Cassius, who is supposed to have been of the sect of the Rationalists, expresses the same sense by the same word.

ENSTORF, in *Geography*, a town of Germany, in the circle of Bavaria and Upper Palatinate; 22 miles N. of Ratibon.

ENT, *Sir GEORGE*, in *Biography*, an eminent physician, was born at Sandwich, in the county of Kent, on the sixth of November, 1604. After going through the usual course of classical instruction, he was sent to Sidney college, in Cambridge. He afterwards travelled to the foreign seats of learning, received the degree of doctor of physic at Padua, and on his return was incorporated in the university of Oxford, on the seventh of November, 1638. During the usurpation of Cromwell he settled in London, where he obtained considerable eminence in the practice of his profession: he was elected a fellow, and afterwards president of the College of Physicians; and at length his merits were rewarded with the honour of knighthood by king Charles II. He enjoyed for a long period the esteem and confidence of the public, and died at the age of eighty-five, on the 13th of October, 1689. He was buried in the church of St. Lawrence in the Jewry. He was a very intimate friend of the celebrated Dr. Harvey, and wrote a defence of his great discovery, entitled "Apologia pro circulatione sanguinis contra Æmilium Parisanum," which was published in 8vo. in the year 1641, and again in 4to. in 1685. About 1651 he prevailed with Dr. Harvey to consent to the publication of his "Exercitationes de generatione animalium," which he superintended, and presented to the College of Physicians in a sensible and elegant dedication. He likewise published a treatise of his own in 1679, which was reprinted in 1682, entitled, "Animadversiones in Malachiz Thruston, M. D. diatribam de respirationis usu primario," in 8vo. His works were collected, and published in one volume 8vo. at Leyden in 1687, under the title of "Georgii Entii Opera omnia Medico-Physica, &c.:" and after his death, his "Observationes ponderis testudinis, cum in autumnno terram subiret, cum ejusdem ex terra verno tempore exeuntis pondere comparati, per plures annos repetitæ," were printed in the Philosophical Transactions, N° 194, anno 1691. See ELOY Dict. Med. Biog. Dict.

ENTABLATURE, in *Architecture*, is that part of an order of column which is over the capital, comprehending the architrave, frieze, and cornice.

The word seems formed of *tabulatum* or *intabulamentum*.

The entablature is also called the *trabeation*, and by Vitruvius and Vignola *ornament*. It is different in the different orders; indeed, it consists of the three grand parts or divisions above-mentioned, in all; but those parts consist

of a greater or less number of particular members or subdivisions, as the orders are more or less rich.

Vignola makes the entablature a quarter of the height of the whole column, in all the orders.

In the Tuscan and Doric, the architrave, frieze, and cornice, are all of the same height; in the Ionic, Corinthian, and Composite, the whole entablature being fifteen parts, five of them are allowed for the architrave, four for the frieze, and six for the cornice. See IONIC, CORINTHIAN, &c. and COLUMN.

ENTABLATURE, or *Entablament*, is sometimes also used for the last rows of stones on the top of the wall of a building, whereon the timber and covering rest.

As this is frequently made to project beyond the naked of the wall to carry off the rain, some authors call it in Latin *stillicidium*, or *drip*. Such an entablature does not stand out far enough; it lets the water fall on the foot of the wall.

ENTABLER, in the *Manege*, is said of a horse whose croupe goes before his shoulders, in working upon volts; for, in the regular manege, one-half of the shoulders ought to go before the croupe. Thus we say, your horse entables; for, in working to the right, he has an inclination to throw himself upon the right heel; which fault you may prevent, by taking hold of the right rein, keeping your right leg near, and removing your left leg as far as the horse's shoulder. A horse cannot commit this fault without committing that called *aculer*; but *æuler* may be without entabler.

ENTAIL, in *Law*, signifies *fee tail*, or *fee entailed*, that is, abridged, curtailed, or limited to certain conditions. For the docking of an entail, see DOCKING and RECOVERY. See TAIL and ESTATE, &c.

ENTALIUM, the *pipe-shell*, in the *Materia Medica*, a shell of the same genus with the dentalia, being a species of the tubuli marini. It is frequent in the East Indies, and sometimes is found on our own shores. The virtues ascribed to it are the same with those of the dentalium; but neither of them have any title to more than those of alkaline absorbents, like the other testaceous powders.

ENTE, in *Heraldry*, literally implies *engrafted*, and is used by foreign heralds to express a method of marshalling, little known among us; yet we have an instance of it in the fourth grand quarter of his majesty's royal ensign, whose blazon is Brunswick and Lunenburgh, impaled with ancient Saxony, *enté in pointe*.

ENTELECHIA, *Ἐντελεχία*, of *εντελεχεια*, *perfect*, a Greek term, by which Aristotle defines the soul; and which, not occurring in any other author, has given the critics and philosophers infinite perplexity to discover its true meaning. See SOUL.

Hermolous Barbarus is even said to have consulted the devil about it; after which, in his paraphrase on Themistius, whether from the devil or himself, we know not, he renders it by *perfectihabia*, which is not a whit the clearer.

Cicero, whose interpretation should be preferable to that of any modern, defines entelechia (Tusc. Quest. lib. i. cap. i.) to be, "a certain, continued, and perpetual motion;" whence it should seem, that Aristotle took the soul for the mode of the body; a continuous motion being, doubtless, a mode of body.

The common Peripatetics hold entelechia to signify act, and under it suppose the form of the compound or animal to be understood.

Lastly, others, and those the latest Peripatetics, agree, that the act, or entelechia, whereby Aristotle meant to explain

plain the nature of the soul, is either some mode of the body, as motion, or it is nothing.

ENTENDEMENT, in *Law*. See INTENDMENT.

ENTER, *To, a Hawk*, among *Sportsmen*, is used of a hawk when the begins to kill.

ENTER, *To, a Hound*. See ENTRANCE of Hounds.

ENTERADENES, of *εντερον*, *intestine*, and *αδην*, *gland*, in *Anatomy*, a name by which many authors have called the intestinal glands.

ENTERENCHYTÆ, of *εντερον*, *the viscera*, and *εγχυσις*, *Infuse*, in *Medicine*, a name given by authors to the several instruments contrived for throwing clysters into the bowels; such as the bladder and pipe the syringe, and the like, for liquid clysters; and the box with the double pipe for conveying the smoke of tobacco. See CLYSTER, and FUMIGATOR.

ENTERFERING, in the *Manege*. See CUTTING.

ENTERITIS, in *Medicine*, from *εντερον*, *intestine*, signifies an inflammation of the intestines. The disease has been variously denominated *ileus*, *ιλιοσ*, *iliac passion*, *chor-dupfus*, &c.

The symptoms of inflammation of the bowels generally come on suddenly. An acute and fixed pain, with a sense of heat in the abdomen, more especially about the umbilicus or navel, often with a feeling of twisting in that part, attacks the patient; this pain is increased by pressure. Previously to its occurrence, or together with it, the usual symptoms of fever come on, such as rigor or shivering, followed by flushes of heat, thirst, and dryness of the tongue; the pulse becomes frequent, hard, and commonly small; considerable anxiety ensues; the bowels are obstinately costive; the stomach is soon deranged; and eructations, nausea, and vomiting succeed. As the disorder advances, the pain becomes more acute, without any disposition to evacuation; the abdomen becomes distended with flatulence, and more tender under pressure; and the urine is often voided with difficulty and pain. If the inflammation be not alleviated, gangrene generally ensues, often within twenty-four hours from the commencement of the disease, and terminates the life of the patient.

The occurrence of gangrene is indicated by a sudden remission of the pain, while, at the same time, the strength fails, the pulse sinks, the voice grows feeble, the countenance shrinks, and assumes even a cadaverous aspect, yet the distension of the belly is not diminished, but often increased. This tendency to terminate speedily in mortification constitutes the great danger of inflammation of the intestines. Sometimes the disease terminates in suppuration, which, though less rapidly fatal, most commonly wears out the patient's strength and life in a lingering manner; but occasionally this condition ends in recovery. The formation of pus is indicated in this disease, as in other internal inflammations, by the remission, but not total cessation of the pain, and by the occurrence of frequent fits of rigor, and sometimes by a purulent discharge by stool. But the disease, especially when the aid of medicine is early and actively obtained, frequently terminates favourably, by resolution, as it is called; *i. e.* by a gradual diminution and cessation of the symptoms. If the pains abate gradually, and the tenderness and distension of the abdomen lessen, while the pulse becomes softer and fuller, natural evacuations of feculent matters are passed, and a free general perspiration breaks out, this favourable termination may be anticipated. Whereas, the continuance of the constipation, and of the fixed pain, the increase of the sickness and vomiting, the occurrence of the symptoms just described as indicative of gangrene, especially if accom-

panied with hiccup and cold sweats, are among the unfavourable prognostics.

The principal source of mistake, into which the practitioner is likely to fall in treating this disease, is in confounding it with *colic*; a spasmodic disorder, which requires a treatment essentially different, but which, nevertheless, occasionally terminates in enteritis. The diagnostic symptoms of the two complaints have been already stated at length, under the former article. See COLICA.

Enteritis occurs most commonly in persons somewhat advanced in life, generally after the age of forty, or fifty; and it seems to be most frequent in plethoric habits, and in those particularly who indulge in indolence and full living. In some individuals there appears to be a constitutional irritability of the intestines, which renders them liable to attacks of inflammation, upon the application of slight causes.

The exciting causes of enteritis are various; among the most common are obstructions in the bowels, which necessarily retain the feces, until these, by their quantity or quality, become extremely irritating, and excite inflammation. These obstructions to the passage of the stools through the intestinal canal are occasioned by different circumstances. A spasmodic contraction of any part of the canal, as in *colic*, if it continue for any considerable time, is liable to induce inflammation: a stricture, occasioned by a chronic thickening of the coats of the bowels, sometimes brings it on: *intro-susception*, or the inverted passage of one part of the gut into the adjoining part, produces a similar effect; as well as the strangulation of the intestine from *hernia*, or rupture: the formation of calculus in the intestinal canal, which, though a rare occurrence, sometimes takes place, may also occasion a similar obstruction, and consequent inflammation. Enteritis is likewise excited by irritating substances conveyed into the intestines, which, by their bulk, shape, or indigestibility, or by their chemical or specific acrimony, produce much excitement in the canals. Thus, the swallowing of hard kernels, seeds, or stones of fruit, or pieces of metal, &c. has often induced the disease; and the presence of *scybala*, or hardened feces, and of calculous concretions, operates partly by the immediate irritation which they occasion. Thus also, strong concentrated acids or alkalis, spirituous liquors, high seasoned food in large quantities, drastic purgatives, worms, &c. in the intestinal canal, have excited inflammation in it in different instances. Hence the disease has sometimes been the immediate effect of repletion, or of a fit of intoxication: and even a mild cathartic, when the bowels were loaded with much hardened feces, which the medicine was incapable of removing, has, in some rare cases, produced inverted motion and *intus-susception*, terminating in enteritis. A very common cause of inflammation in the bowels is the application of cold to the legs and feet, or to the abdomen itself, especially if sudden or long continued. The retrocession of gout, rheumatism, erysipelas, or chronic eruptions, from the external parts, is sometimes followed by symptoms of intestinal inflammation.

In the *cure* of enteritis, as in all other acute inflammatory diseases, the leading object is to remove the inflammation, from which all the other symptoms of the disease originate. This, though apparently an identical proposition, cannot be too strongly inculcated, in the treatment of enteritis; because the excessive constipation of the bowels, which, in common with the rest of the symptoms, is in general merely an effect of the inflammatory condition of the bowels, in some part, is often attacked by the inattentive practitioner with active purgative medicines, as if it were the primary object, and the source of all the mischief. The inflammation

tion is to be subdued by blood-letting, from a large orifice, to an extent which must be various according to the constitution of the patient, and the violence of the symptoms. This depletion may be aided in its effects by the application of leeches, and afterwards of a blister to the abdomen; and by the strictest abstinence from all stimulating and nutritious aliment. The blood-letting must be repeated in a short time, if the symptoms do not abate, and the strength of the patient is sufficient to support the evacuation; which can only be determined by the observation and experience of the practitioner. If the pulse should become fuller and less wiry after the operation, it will afford a strong reason for the repetition of it, should the continuance of other symptoms appear to require it. The use of emollients externally was in great vogue among the ancients; and fomentations, or, what is better, the warm bath, may be resorted to with advantage. Celsus recommends the use of warm cataplasms, frequently changed, and covering the greater part of the trunk, "à mammis usque ad inguina et spiniam," and also a bath of warm oil;—"demittere totum hominem in calidum oleum." De Medicinâ, lib. iv. cap. 13. The dirty applications of living animals, or the skins of those recently killed, can only operate as emollients, and are necessarily less effectual than fomentations; they are at present, therefore, fallen into disuse. Sydenham recommended the application of a live whelp to the abdomen in these cases. Opera, sect. i. cap. 4. p. 77. Edit. Lugd. 1726.

It must be obvious, that before the inflammation of the intestines is lessened or removed by these measures, any additional irritation to the membranes, already in an acute state of sensibility, whether by the immediate stimulus of a cathartic medicine, or by the contents of the bowels being forced forwards to the inflamed part, must tend to aggravate the disorder, rather than to relieve it. In fact it is usually found, that purgatives, given by the mouth, are not successful, where this previous diminution of the inflammation has not been effected. And when this has been accomplished, some of the milder purgatives, as the neutral salts, should first be administered, the action of the intestines downwards being at the same time solicited by emollient glysters, which also contribute to the same relaxant purposes as the external fomentations. Dr. Gregory used to remark, in his lectures, that a purgative medicine had often been known to operate as soon as a blister, applied to the belly, began to rise, which had not acted previously: and this observation is still more commonly verified, after a free evacuation by blood-letting. See Edinburgh Med. and Surg. Journal, vol. i. p. 64. Some practitioners have attempted to open a passage for the fæces, by mechanically distending the large intestines, by throwing up five, six, or seven pints of warm water with an injecting syringe. This expedient may be useful in spasmodic colic; but it is objectionable, in enteritis, on several grounds. Such distension can only be accomplished in the colon, or great gut; whereas the obstruction by inflammation is commonly in some portion of the small intestines, and therefore out of the reach of the enema. In the next place, any forcible distension of an inflamed and thickened canal, if it could be accomplished, would rather conduce to an increase of the inflammatory condition, than to lessen it by the removal of fæces. In a word, all measures applied to the inflamed intestine should be mild; since forcible ones cannot but augment the inflammation, upon which the impeded function of the organ depends. By way of glyster, therefore, a little common salt, magnesia vitriolata, or infusion of fenna, with gruel or warm water, will probably answer every good purpose that can be expected from such an expedient. Tobacco smoke has been often injected when

milder means have failed, or infusions of tobacco; but their success, we believe, has not been often experienced. Indeed tobacco injections are liable to produce great sickness and irritation, if that herb be not used in very small quantities.

The extreme sickness which often accompanies enteritis, and by which every thing that is taken into the stomach, whether liquid or solid, is rejected, renders it difficult, in some cases, to produce any effect upon the bowels by internal medicine. In this case, the irritability of the stomach may be quieted by the saline effervescent draught, or by a small opium pill, or, if this be rejected, by an opiate given in a glyster; after which the necessary laxative medicines may be retained, and accomplish the intended object. It should be observed, however, that the stimulus of opium will prove rather injurious than useful, while the inflammation is unsubdued.

Where the inflammation has arisen from strangulated hernia, the operation, by which the strangulation is removed, and the intestine returned into its place, can alone save the life of the patient. See HERNIA.

We have already had occasion to allude to a remedy for constipation of the bowels, which has been recommended as a last resource, namely, a quantity of crude quicksilver; and to point out the absurdity of the hypotheses, which have led to its use, as well as some of the ill consequences of it. Sydenham reprobates the practice, which appears to have been first adopted about his time. Loc. cit. p. 76. See CONSTIPATION.

When the inflammation of the intestines has been subdued, the utmost caution should be employed, with a view to the prevention of a relapse, to which the convalescent from enteritis is extremely liable. A thin, spare, and laxative diet, consisting of vegetable substances, of gruels, or barley water, or these mixed with milk, must be adhered to most rigidly for a considerable time after recovery; and all acrid, stimulating substances, or those which are difficult of digestion, should be most scrupulously avoided. The most fatal effects have been observed to take place, in some instances, from returning too soon to ordinary diet, after the removal of inflammation of the bowels. In order to guard against a future recurrence of the disease, the application of cold to the abdomen and feet should be prevented by warm cloathing; and the occurrence of costiveness at all times avoided, by laxative diet or medicine, so that no accumulation of fæces can take place, and the steady action of the bowels be constantly preserved.

ENTERMEW. See FALCON.

ENTEROCE'LE, (from *εἰστρον*, an intestine, and *κελε*, a tumor, or rupture,) in Surgery; a hernia is so termed, when its contents are entirely composed of intestine.

ENTERODYNIA, from *εἰστρον*, intestine, and *δύνη*, pain, in Medicine, a term used by some writers, as nearly synonymous with colic, but expressing a minor degree of pain; such, for instance, as arises from the irritation of vitiated bile, loaded bowels, worms, &c. and which, therefore, laxative medicines generally relieve.

ENTERO-EPIPOCE'LE, (from *εἰστρον*, an intestine, *επιπλοον*, the omentum, and *κελε*, a tumor,) in Surgery, a term applied to a hernia, which contains both a portion of the bowels, and a piece of the omentum.

ENTERO-HYDROCE'LE, (from *εἰστρον*, an intestine, and *υδροκελη*, a dropsy of the scrotum,) a scrotal hernia, containing a good deal of fluid.

ENTEROLOGY, from *εντερον*, intestine, a gut, and *λογος*, sermo, discourse,) is properly a treatise of the bowels. Though the word is generally understood to include the

contents of three cavities, head, breast, and all the viscera or belly.

**ENTEROMPHALOS**, (from *εντερον*, an intestine, and *ομφαλος*, the navel,) a hernia at the navel, and containing intestine.

**ENTERORAPHÉ**, (from *εντερον*, an intestine, and *ραφη*, a suture,) a suture of the bowels.

**ENTEROSCHEOCELE**, (from *εντερον*, an intestine, and *σχοκολλησις*, a rupture, or hernia situated in the scrotum,) a scrotal hernia, the contents of which are entirely composed of intestine.

**ENTERPEN**, *To*, in *Falconry*, is a term applied to a hawk, when her feathers are wrapped up, snarled, or entangled.

**ENTERPLEADER**, in *Law*. See **INTERPLEADER**.

**ENTERPRISE**, denotes an undertaking attended with some difficulty and danger.

**ENTERPRISE**, in *Military Affairs*, appertains rather to those desultory expeditions which often prove of considerable importance in their consequences; though, perhaps, apparently trivial, when compared with those great events that sometimes characterize a campaign. In some instances we see the most decided effects produced by the operations of enterprising partisans, who, exclusive of the quantity of forage, and the intelligence they generally afford, distress the enemy severely, by compelling him to act with such circumspection, and so to strengthen his positions, as inevitably must weaken his other operations, as well as create considerable alarm among his troops, especially when detached in exposed situations.

In some countries; detached enterprises seem to constitute the chief incidents in warfare; thus, we find that irregular corps commanded by baron Trenck were peculiarly active, and harassed the enemy beyond measure! Thus, also, the Croats, the Pandours, and the Pindaries, of the Mahratta empire, the Sooties under the late Tippoo, and various other such predatory establishments, commanded by officers of a suitable disposition, have ever been famous for annoying, and for cutting off the supplies of their adversaries.

No enterprise, whether military or naval, should be entrusted to the charge or conduct of an individual deficient in any one of the requisites for such a responsible, and, indeed, so arduous an appointment. In the first place, a knowledge of the geography of that country he is to invest, and of the language of its inhabitants, is indispensably requisite. His character for marked personal courage, and for the prompt application of suitable remedies against every species of disaster, or of disappointment, should be conspicuous. He should possess that kind of deportment which preserves the strictest subordination, while it secures the affection, and excites the admiration, of all under his command. He should be expert in all military exercises, and possess both an active mind, and the soundest constitution. With such valuable gifts, added to a certain conciliatory mode of conduct towards the peasantry, &c. of the district in which he is to carry on his enterprises, a partisan may perform wonders, and far outdo all the exploits an equal number of regulars could achieve under a less capable leader. The truth is, that, generally speaking, soldiers and sailors are mere automatons, acting under the direction of an expert machinist, whose character is ever appreciated according to the success of his movements. How far permanent reputation may be established by the commander of such an auxiliary force, may be collected from that dread which was created by the Tarleton legion among the Americans, during their struggle with the mother country. That legion, even at

this day, are spoken of in terms of admiration, by the very people who suffered so severely from the exertions and abilities of its commander.

It being obvious that, on many occasions, an army must depend greatly for supplies on the activity and talents of a partisan, we cannot too forcibly point out the peremptory necessity which exists, for the rejection of all who may be deficient in the above qualities, without which, it is unreasonable to expect that any enterprise of moment should ever be safe to those who might be employed; much less could it be of service to those in whose behalf it might be undertaken. Naval enterprises require no less attention in some cases; though, for the most part, we find them rather indebted for success to undaunted bravery, and a moderate portion of judgment. These ordinarily are made under cover of, or supported by, some sufficient force; whereby, in case of defeat, they are rescued from total ruin: whereas, the military partisan rarely has such protection at hand.

**ENTERSOLE**. See **MEZANINE**.

**ENTERTAIN**. This term has, no doubt, crept into military phraseology in consequence of the entertainment afforded at public-houses, &c. to such candidates as prefer a scarlet coat and a musket, to a frock and a pitch-fork. We cannot sufficiently express our regret, that no better mode has been ordinarily brought into practice, than that of plying men with liquor for the purpose of inducing them to enlist. We are, indeed, rather infidels on the subject of any numerous accessions to the real strength of our armies, in consequence of this custom: for we have had occasion to learn, that a very large portion of the recruits obtained in consequence of inebriety, either abscond at some favourable moment, or prove to be the worst soldiers in their regiment. If drunkenness has been habitual to them, they rarely relinquish their addictedness to liquor; and if, on the contrary, they had, until the moment of being enlisted, been of a sober disposition, their peace of mind is totally destroyed, and they serve without alacrity, without zeal, and generally, too, without health: they are often known to fall a prey to remorse!

We are sensible that, speaking abstractedly, the affording of entertainment to persons who appear desirous of enlisting, may be defended under the plea of state necessity; but it becomes a very serious question, whether the nation does not pay considerably more in consequence of the monies expended in this way? also, whether it is sound policy to allow military persons to be in any shape concerned in overwhelming the senses of that man, who is to be for life associated with them, and who will not always be unmindful of the condition to which they may have brought him? To condemn a practice, said to be so necessary towards our safety as an independent nation, without offering a substitute of a more favourable description, might, perhaps, justly subject us to the imputation of presumptuously branding the existing custom with obloquy; we shall, therefore, briefly remark, that, in all probability, not only as many, but more, valuable recruits would be obtained by desisting from what is vulgarly called *entertaining* the candidates; and from expending a very large portion of his bounty in liquor, race-shows, and such dissipations as "make him poor indeed!" In place of this, let the whole of his bounty-money be given to the parish from which he may have been taken, for the support of his family; and let the recruit himself be subsisted and clothed entirely at the expence of the state. Should the recruit have no family subject to parochial aid, or likely to be so, let his bounty money be reserved until he should have served a certain time, and then to be given to him in instalments: so that he might not dissipate the whole adventitiously,

ventitiously, and that he should be enabled, from time to time, to provide himself with various articles of apparel, or of comfort, suited to his profession.

We cannot close this subject without strongly reprobating the practice of stopping certain sums, for off-reckonings, and necessaries. If the soldier is to pay for them, let it be by a plain and peremptory reduction of his pay, in exchange for which he should receive certain articles from government; but let there be no account-current between the soldier and his officer, for feathers, lace, buckles, canteens, knapsacks, and such like: this kind of dealing sets aside that respect which the former ought always to entertain for the latter, and, not unfrequently, occasions a certain kind of suspicion by no means tending to promote either esteem or subordination. While reform seems to be the order of the day, it may, perhaps, be at least fashionable, if not praiseworthy, to point out this as an instance in which much melioration might be very easily, and safely, effected.

ENTERTAINMENTS, *epulae*, among the ancients, were of various kinds, as, 1. Funeral entertainments, *epulae funebres*. 2. Entertainments given by the husband on bringing home his wife, called *epulae geniales*. 3. Those bestowed on the soldiers, called *epulae militares*; which was done before or after an engagement, or on occasion of proclaiming the general imperator. 4. Birth-day entertainments, *epulae natalitiae*.

There were many other kinds, denominated either from the place where, the persons by whom, or the occasion for which they were given.

INTERVIEW, in *Falconry*, a term used for the second year of a hawk's age.

ENTHALIUM, in *Natural History*, a name given by some to a species of the tubuli marii, more usually known by the name of penicillum marinum, and pinceau de mer. See *PENICILLI Marini*.

ENTHUSIASM, *Εθουσιασμος*, a poetic, or prophetic rage or fury, which transports the mind, inflames and raises the imagination, and makes it conceive and express things extraordinary and surprising.

The word is derived from the Greek, *εθεος*, or *εθευς*, a man animated in an extraordinary manner with the spirit of God; in whom God is, or whom God animates. Whence the verb *εθεουσαζω*, or *εθεουσαω*, and the noun *εθεουσιασμος*, *enthusiasm*: and *εθεουσιαστης*, *enthusiast*, a person subject to such transports.

M. de Piles defines enthusiasm to be a transport of the mind, whereby it is led to think and imagine things in a sublime, surprising, yet probable manner.

The sublime he thinks a necessary ingredient in the definition, as being the proper effect and production of enthusiasm.

This is the enthusiasm felt in poetry, oratory, music, painting, sculpture, &c. (see the next article); but this enthusiasm which belongs to the works of art, is very different from that attributed to the sibyls and priestesses of the oracles, and heathen gods, which was little else but fanaticism, and consisted principally in grimace, and contortions of the body. See *ORACLE* and *PYTHIAN*.

There is a degree of assent, says Mr. Locke, which, with some men, has the same authority as either faith or reason; and that is enthusiasm, which, laying by reason, would set up revelation without it; whereby, in effect, it takes away both reason and revelation, and substitutes in the room of it the ungrounded fancies of a man's own brain, and assumes them for a foundation, both of opinion and conduct.

Immediate revelation being a much easier way for men to

establish their opinions, and regulate their conduct by, than the tedious labour of strict reasoning; it is no wonder, that some have been very apt to pretend to it: especially in such of their actions and opinions as they cannot account for by the ordinary methods of knowledge and principles of reason. Hence we see, that in all ages men in whom melancholy has mixed with devotion, or whose conceit of themselves has raised them into an opinion of a greater familiarity with God than is allowed others, have often flattered themselves with the persuasion of an immediate intercourse with the Deity, and frequent communications with the Divine spirit.

Their minds being thus prepared, whatever groundless opinion comes to settle itself strongly upon their fancies, is an illumination from the spirit of God; and, whatsoever odd action they find in themselves an inclination to do, that impulse is concluded to be a call or direction from heaven, and must be obeyed.

This we take to be properly enthusiasm; which, though rising from the conceit of a warm and over-weening brain, works, where it once gets footing, more powerfully on the persuasions and actions of men than either reason or revelation, or both together; men being most forwardly obedient to the impulses they receive from themselves.

When men are once got into this way of immediate revelation, of illumination without search, and certainty without proof, reason is lost upon them; they are above it; they see the light infused into their understanding, and they cannot be mistaken: like the light of bright sun-shine, it shews itself, and needs no other proof but its own evidence; they feel the hand of God moving them within, and the impulses of the spirit, and cannot be mistaken in what they feel. But, of this seeming and feeling, it is a perception of an inclination to do something, or of the Spirit of God moving that inclination: these are two very different perceptions, and should be carefully distinguished.

If they know the thing to be a truth, they must do it, either by its own self-evidence, or by the rational proofs that make it out to be so: if they know it to be a truth, either of these two ways, they in vain suppose it to be a revelation; for thus, all truths, of what kind soever, which men uninspired are enlightened with, come into their minds. If they say, they know it to be true, because it is a revelation from God, the reason is good; but then it will be demanded, how they know it to be a revelation from God? If they say, by the light it brings with it, they should consider, whether this be saying any more than that it is a revelation, because they believe it to be true; for all the light they speak of is but a strong persuasion of their own minds that it is a truth, which is a very unsafe ground to proceed on, either in our tenets or actions. True light in the mind is nothing else but the evidence of the truth of any proposition; and if it be not self-evident, all the light it can have is from the clearness of those proofs upon which it is received. See *EVIDENCE*.

God, when he makes the prophet, doth not unmake the man; he leaves his faculties in their natural state, to enable him to judge of his inspirations, whether they be of divine original or not. If he would have us assent to the truth of any proposition, he either evidences that truth by the usual methods of natural reason, or else makes it known to be a truth which he would have us assent to by his authority; and convinces us that it is from him, by some marks which reason cannot be mistaken in. *Essay on Hum. Underst.* book iv. chap. 19.

The holy men of old, who had revelations from God, had something else besides internal light, of assurance in their

## ENTHUSIASM.

their own minds, to testify to them that it was from God; they had outward signs to convince them of the Author of those revelations; and when they were to convince others, they had a power given them to justify the truth of their commission from heaven; and by visible signs, to assert the divine authority of the message they were sent with. Moses saw the bush burning without being consumed, and heard a voice out of it. God, by another miracle, of his rod turned into a serpent, assured him likewise of a power to testify his mission, by the same miracle repeated before those to whom he was sent.

Enthusiasm is defined by Dr. Hartley (*Obs. on Man*) to be a mistaken persuasion in any person, that he is a peculiar favourite with God; and that he receives supernatural marks thereof. The vividness of the ideas of this class easily generates this false persuasion in persons of strong fancies, little experience in divine things, and narrow understandings, (and especially where the moral sense, and the scrupulosity attending its growth and improvement, are but imperfectly formed,) by giving a reality and certainty to all the reveries of a man's own mind, and cementing the associations in a preternatural manner. It may also be easily contracted by contagion, as daily experience shews; and indeed more easily than most other dispositions, from the glaring language used by enthusiasts, and from the great flattery and support which enthusiasm affords to pride and self-conceit. The ingredients, says lord Lyttelton in his "Observations on the Conversion, &c. of St. Paul," of which enthusiasm is generally composed, are great heat of temper, melancholy, ignorance, credulity, and vanity, or self-conceit.

The true sources of enthusiasm, says Mr. Hume in his "Essay on Superstition and Enthusiasm," are hope, pride, presumption, a warm imagination, together with ignorance. From the influence of these causes arise raptures, transports, and surprising flights of fancy; and whilst confidence and presumption still increase, these raptures, being altogether unaccountable, and seeming quite beyond the reach of our ordinary faculties, are attributed to the immediate inspiration of that Divine Being, who is the object of devotion. In a little time the inspired person comes to regard himself as a distinguished favourite of the Divinity; and when this phrensy once takes place, which is the summit of enthusiasm, every whimsy is consecrated. Human reason, and even morality, are rejected as fallacious guides; and the fanatic madman delivers himself over, blindly, and without reserve, to the supposed illapses of the spirit, and to inspiration from above.

Devotion, undirected, or unrestrained by reason, degenerates into enthusiasm, or a religious phrensy, founded in an apprehension of a present Divine energy on the mind, to which all its powers are supposed to be subject, and by which a person is carried on without attention to any thing else as his guide, and producing not only great perturbation of mind, but most amazing agitations of body. Many instances of this kind occur, both in ancient and modern times, to the disgrace and injury of rational religion.

Mr. Hume (*ubi supra*) makes several reflections concerning the different influences of enthusiasm and *superstition* (which see) on government and society. He observes, *first*, that superstition is favourable to priestly power, and enthusiasm not less, or rather more, contrary to it than sound reason and philosophy. He observes, *secondly*, that religions, which partake of enthusiasm, are, on their first rise, more furious and violent than those which partake of superstition; but in a little time become more gentle and moderate. When enthusiasm rises to that height as to inspire

the deluded fanatic with the opinion of divine illuminations; and with a contempt for the common rules of reason, morality, and prudence, it produces the most cruel disorders in human society; but its fury is like that of thunder and tempest, which exhaust themselves in a little time, and leave the air more calm and serene than it was before. When the first fire of enthusiasm is spent, men naturally, in all fanatical sects, sink into the greatest remissness and coolness in sacred matters; there being no body of men among them, endowed with sufficient authority, whose interest is concerned to support the religious spirit: no rites, no ceremonies, no holy observances, which may enter into the common train of life, and preserve the sacred principles from oblivion. For the influence of superstition, see that article. He observes, *thirdly*, that superstition is an enemy to civil liberty, and enthusiasm a friend to it.

ENTHUSIASM, in *Poetry, Eloquence, and Elocution*, is a species of rapturous elevation and fervour, which transports the writer or speaker beyond the limits of apparent rule, and mere methodical propriety. Like genuine sublimity, to which it is very nearly allied, and with which it occasionally co-operates, in producing the highest impressions that can result from human eloquence, it defies, perhaps, the exactness of logical definition; its very essence consisting in a state of feeling, at once so potent and so evanescent, as to elude the cautious touch of analysis. It belongs, therefore, only to persons of superior genius, and by such alone must be attempted; since, like all superlative excellencies, it verges for ever on the brink of absurdity; and criticism has never yet been able to erect a sufficient barrier to defend its utmost limits. Like every other passion, it must be felt before it can be expressed; and the mind of the writer or the speaker must be well fortified with knowledge on the subject he is handling, and the judgment well exercised in the nice discriminations of taste, of feeling, and of decorum, before he ventures to indulge it in composition or in delivery, if he addresses himself to the enlightened or educated portions of the community, or he will be worse than disappointed of his object. In circles of a different description, however, it is evident that the mere semblance of enthusiasm, unaided by these preliminary qualifications, seldom fails of a very powerful effect: and, by this quality alone, bigotry and fanaticism frequently accomplish their end, and maintain absolute dominion over the minds of their ignorant votaries. It is therefore sufficiently obvious, that it is a quality the orator, if he be susceptible of it, should never fail to cherish; and if he be not susceptible of it, he is but a fragment of an orator. As for poetry, enthusiasm is admitted to be its very soul and essence. In the delivery of eloquence, or the recitation of poetry, genuine enthusiasm is expressed by a deep and powerful aspiration, by an increase of quantity in all the syllables principally produced by the prolongation and increase of the power of the voice on the liquids and liquifiable consonants; a restrained vehemence, which, without any of the disgusting effects of vociferation, spreads the undulations of sound through an extended circle. It is generally accompanied by a considerable dilatation of the nostrils, a protrusion of the eye-balls, and great tension and rigidity of the whole muscular system. Shakespeare, who felt its influence so frequently, has finely described its operation in the speech of Henry V. before Harfleur:

"Now set the teeth, and stretch the nostrils wide,  
Hold hard the breath, and bend up every spirit  
To its full height."

The whole speech is one of the finest effusions of enthusiasm.

fiatm ever penned, and requires in the reciter all the inspiration of that powerful feeling.

**ENTHUSIAST**, *Ενθουσιάζων*, a person possessed with enthusiasm. See **ENTHUSIASM**, **FANATIC**, &c.

The word is generally understood in an ill sense. It was applied by the ancients to a sect of heretics, called also Massalians and Euchites; who, as Theodoret expresses it, were denominated enthusiasts, because being possessed by the devil, they believed themselves divinely inspired. See **MASSALIANS** and **EUCHITES**.

Among us, enthusiast is sometimes of like import with fanatic, and is applied to the Quakers, and ancient Anabaptists, and modern prophets, from their pretences to extraordinary lights, revelations, visions, impulses, &c. from heaven.

**ENTHYMEME**, in *Logic* and *Rhetoric*, an argument consisting only of two propositions, an antecedent, and a consequent deduced from it.

The word is Greek, *ενθυμημα*, formed of the verb *ενθυμησθαι*, to think, conceive, a compound of *εν* and *θυμος*, mind.

Aristotle calls it the rhetorical or probable argument; the schools, the imperfect syllogism, in contradistinction to the perfect, which consists of three propositions, and is called the dialectical argument.

It must be observed, however, that the enthymeme is really a perfect syllogism in the mind, and only imperfect in the expression, because one of these premises is suppressed, as being sufficiently clear and obvious, and easily supplied by the understanding of those with whom we discourse.

Thus, in every right-lined triangle, the three angles are equal to two right ones; and consequently, they are so in an isosceles triangle, is an enthymeme; the proposition, that an isosceles triangle is a right-lined triangle being omitted, as being sufficiently known and granted.

The enthymeme is the most simple and elegant of all argumentations; being what a man, in arguing closely, commonly makes, without attending at all to the form. Thus, that verse remaining of Ovid's tragedy, entitled *Medea*, contains an enthymeme: "Servare potui, perdere an possum rogas:" "I was able to save you; consequently, to have destroyed you." All the beauty would have been lost, had all the propositions been expressed; the mind is displeased with a rehearsal of what is no ways necessary.

Sometimes, also, the two propositions of an enthymeme are both included in a single proposition, which Aristotle calls an enthymematical sentence, and gives this instance thereof: "Mortal, do not bear an immortal hatred." The whole enthymeme would be, "Thou art mortal; let not, therefore, thy hatred be immortal."

**ENTIER**, in the *Mange*, is used for a sort of refty horse, that refuses to turn, and is so far from following or observing the hand, that he resists it. If your horse is entier, and refuses to turn to what hand you will, provided he flies, or parts from the heels, you have a remedy. by putting the Newcastle on him; that is a cavesson, made after the duke of Newcastle's way.

The word is French, and is also used among them to denote a stone-horse.

This term, in its common acceptation, is applied to a horse that refuses to turn, and whose refusal proceeds from the awkwardness and stiffness of the body and limbs, and sometimes from malice and bad habits. In some cases, a hurt in his foot, leg, or shoulder, may be the cause of his refusing to turn to that side where he feels any pain. A hurt in his reins or haunches, a curb or spaving, which, by hindering him to bend and rest upon his hocks, may make

him guilty of this disobedience. These are evils which art can do little towards curing. The term entier, in its figurative sense, in which it is always to be understood in horsemanship, means a stiff horse, or one that is not suppled, and therefore refuses to turn, from the pain and difficulty which he finds in putting himself into a proper posture. Accordingly the Italians, from whom the terms of horsemanship are chiefly taken and adopted, or naturalized by other nations, figuratively call a stiff and undisciplined horse, a whole, entire, or unbroken horse; which, from the stiffness and tightness of his joints and muscles, is not able to bend himself, but in turning moves all of a piece, like a beam, or bar of iron; while the active and suppled horse, who can bend himself readily, and becomes part of the circle he describes in turning, may be said, like a chain, so to loosen and shift his limbs, as to break and divide himself, as it were, into parts; whence, perhaps, the term "horse-breaker," for one who forms the paces, and qualifies horses for being rode. Berenger's *History and Art of Horsemanship*, vol. ii.

**ENTIERTIE**, from the French *entier*, is used in our *Law-books*, in contradistinction to moiety, and denotes the whole. Thus a bond, damages, &c. are said to be entire, when they cannot be divided or apportioned.

**ENTIRE LEAF**, in *Systematic Botany*, *folium integerrimum*, a leaf whose edge is not cut or toothed; the term has no reference to *folium integrum*, an undivided leaf, which last is destitute of lobes or segments, without regard to its margin.

**ENTIRE Tenancy**, in *Law*, is contradistinguished to *several tenancy*, and signifies a sole possession in one man; whereas the other denotes a joint, or common one, in several. See **TENANT** and **JOINT-TENANT**.

**ENTIRE Arms**. See **ARMS**.

**ENTITATIVELY**, **ENTITATIVE**, implies an abstraction, or separation of all the circumstances, from a thing under consideration.

Thus, a thing is said to be taken or considered entitatively, or *secundum entitatem*, when considered nakedly and precisely, according to what it is in itself, without any thing extrinsic. *E. gr.* Peter entitatively taken, is Peter, as a thing, a substance, a man, &c. without any regard to his being a lord, a husband, learned, &c.

**ENTITY**, in the *School Philosophy*, a physical ens, or being, considered according to what it is in its natural capacity.

Some dealers in distinctions give us several kinds of entity.

Or, entity denotes the actual essence or existence of any thinking thing. See **ENS**.

**ENTLIBUCH**, in *Geography*, a village of Switzerland, in the canton of Lucern, the principal place of a bailliage, which extends from the Emme-thal in the canton of Bern to the bridge near Wertenstein, about 15 miles in length and 9 in its greatest breadth; and contains 11,000 persons. It is governed by a bailiff, who is always a senator of Lucern; he continues in office two years, and generally resides in that capital. The bailliage is divided into three districts; the upper, or Eschlismat, the middle, or Shuepfen, and the lower, or Entlibuch; each of which has its separate courts of justice, from which an appeal lies to Lucern. The valley of Entlibuch is watered by several rivulets, winding for some way between two ridges of well-wooded hills, and abounding in picturesque scenery. It contains several villages, of which the principal are Eschlismat, Shuepfen, and Entlibuch, which takes its name from the river Entle, and gives it to the whole district. The inhabitants chiefly follow

low agriculture; they rear large quantities of horned cattle, sheep, goats, and swine; they also make and export cheese in great abundance. The peasants of Entlibuch are much esteemed for their independent spirit, vigour, and strength; and are remarkable for keeness and vivacity, for great quickness in repartee, for a peculiarity of garb, and for many striking customs, which distinguish them from the natives of circumjacent districts. The valley of Entlibuch may be considered as one of those parts which unite with the mild and cultivated the wild and rugged scenery of Switzerland; its acclivities gradually ascend and terminate in mount Pilate, whose barren top is seen towering above the fertile and well-wooded hills. In the 13th century, Entlibuch was subject to the counts of Wolhausen, and came by purchase, in 1299, to the emperor Albert. In the following century it was held as a fief from the house of Austria by several successive counts; till the nation, grievously oppressed by Peter of Torrenberg in 1386, threw itself under the protection of Lucern. That republic continued to possess Entlibuch, as a feudal tenure under the house of Austria, till the year 1405; when the archduke Frederic renounced all the rights of sovereignty. For above a century and a half, the inhabitants, inflamed with a desire of independence, and excited by the example of the popular cantons, frequently rose in arms, and attempted to establish a democracy, but without success. Their last insurrection broke out in 1653; since which time they have continued in a state of perfect tranquillity under the administration of Lucern, enjoying, with contentment, the privileges with which they are endowed. The peasants of Entlibuch were distinguished by their attachment to the government, and by their decided opposition to French principles, during the late revolution. Coxe's Travels in Switzerland, vol. i.

ENTOGANUM, in *Botany*, Gærtn. t. 68. See MELICOPE.

ENTOMOLITHUS, in *Natural History and Mineralogy*, is the name of a genus of the animal order of remains (*reliquia*, or *relicts*) of a former race of beings, which inhabited the earth or its waters, and includes the different kinds of insects found in a fossil state. According to Mr. William Martin (*Outlines of the Knowledge of extraneous Fossils*, p. 191), the essential characters, or diagnostics of the permanent species in this genus, are to be sought, in "the upper external covering of the thorax, united to that of the abdomen;" the temporary species of this genus are to comprise the detached head, thorax, abdomen, limbs, &c. of fossil animals, resembling the recent species of insects. See RELIQUIA.

ENTOMOLOGY, the science of insects, or, as literally rendered from the Greek, a *discourse on insects*; the term by which the study of these animated beings is expressed.

Insect, from *insectum*, Latin, is of later origin than *έντομα*, the term made use of by Aristotle, who flourished in the fifth century, before the Christian era, and was invented much earlier than the time of that celebrated philosopher. Aristotle defines it to signify an animal which by incisions is nearly severed into two or more parts, and the Latins, long before the time of Pliny, (who lived in the reign of Titus,) employed the word *insectum*, from *insecor*, which precisely bears the same interpretation.

The insect race constitutes the most considerable portion of the whole class of organized bodies possessing the vital principle of life. The number of aquatic beings concealed from our research in the depths of the ocean cannot be within the reach of human estimate; it is to the terrestrial tribes, or those which inhabit the surface of our globe, that we alone allude; and the entire amount of these, including every order,

is confessedly inferior in point of number to the single class of insects. Among the larger animals the discovery of a few new species, or of individuals not correctly ascertained before, is esteemed of consequence; but so extensive are the limits of entomology, that the discovery of a multitude of insects under the same circumstances fail to excite astonishment, though it may awaken curiosity; and, indeed, its frequency seems calculated to confirm the commonly received opinion, that the insect race, in the diversity of species, much more in the number of its individuals, must be almost boundless.

In this view the science of entomology becomes one of the most important that can engage the mind of the natural philosopher. It is the difficulty of discriminating the particular affinities and characters of these beings, arising from their amazing number and variety of form, in addition to their minuteness, that more strongly enforces their claim to his consideration. The naturalist who neglects the study of insects, cannot deserve our respect as a general observer of nature. His views are partial; his enquiries circumscribed; he regards only an inconsiderable portion of animated nature; and his remarks are confined chiefly to those which, from their magnitude and distinctness of character, present the least obstacle to investigation.

The study of every class of animals is indisputably attended with peculiar advantages; and in none is this assurance more clearly manifested than in the tribe of insects. In the mazy labyrinth of entomology, the naturalist will find abundant scope for the exercise of his zeal and application, and in the course of his enquiries the full exertion of his penetration will be oftentimes required to the ascertainment of truth. The amazing number of species it embraces; their forms so extraordinary; so infinitely varied; and yet so gradually approximating through an endless series of transitions from one species to another; the diversity of structure observable in their antennæ, their limbs, bodies, wings, and every other particular which constitute the essential differences of their orders, genera, and species; added to the surprising changes in form which the generality of insects undergo at stated periods of their life:—these are circumstances which contribute to render them objects of the most curious speculation to the naturalist, and we shall venture to affirm, that it is from a knowledge of these, their characters, transitions, metamorphosis, and the various modes of life these little beings are destined to pursue, that he will obtain a more intimate acquaintance with the great laws of animated nature, than can possibly be derived from the contemplation of any other tribe in the creation.

As insects surpass all other animals in their number, variety, and singularity, so also it is a natural inference that they must deserve the greatest share of attention. The history of these creatures abound with the most valuable information in a philosophic view, and strongly recommend the study to the attention of every curious observer. Entomology possesses many other attractions, some at least of which have not been well considered. The only one to which we shall particularly advert at this moment, is the beauty of insects in general, a point on which there can be no difference of opinion. These little creatures are rendered engaging from the gaiety of their natural hues: from combining oftentimes with the most graceful forms a display of colouring very far excelling in splendour, vivacity, delicacy, and harmony of disposition, that bestowed by the hand of nature on her other works. One defect in their appearance must be nevertheless conceded; and this may be regarded in point of beauty as a material deficiency indeed: they are not always so considerable in magnitude, as to become, even with these embel-

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ishments, strikingly attractive: were they only equal in size to the minor tribes of birds and animals, their unrivalled elegance would certainly render them objects of high esteem in the general opinion of mankind.

But the diminitiveness of insects ought to operate in a contrary manner on the mind of the philosopher. While this cause opposes the greater difficulty to the study, it should more strongly incite investigation. This we are aware is not always considered as an inducement, and the diminitiveness of these creatures has been sometimes urged as a reason that they do not merit the attention bestowed upon them. However injudicious this opinion ought in candour to be conceived, it has obtained the countenance of many; and among the number, of some men at least who, from their superiority of talent, might be deemed incapable of advancing such an argument against the study of any department of natural science. Thus the ingenious Buffon, whose attention, as is well known, was restricted to the larger tribes of animals, intimates its inferiority in language sufficiently pointed. "Who (says this lively author) gives us the grandest and most magnificent ideas of the creator of the universe? he who represents him in the plenitude of his power, directing the formation of suns and of planets, and guiding the revolutions of worlds, or he who discovers him busied in regulating the economy of a hive of bees, or deeply engaged in folding the wings of a beetle?"

How different is this from the sentiments expressed by other philosophers, who, with more enlarged and liberal views, have held every branch of natural science in its proper estimation! There are many who even assign a higher degree of perfection to the insect race than to other classes of animals. We learn the opinion of Pliny from his own words. "In his tam parvis tamque fere nullis quæ ratio! quanta vis! quam inextricabilis perfectio!" Boyle declares, that for his own part his wonder was more excited by the contemplation of a mite than an elephant; and Reaumur speaks more decidedly to the same effect, in language worthy of repetition. Pourquoi, (says this author,) craignons-nous de trop louer les ouvrages de l'Être Suprême? Une machine nous paroît d'autant plus admirable, et elle fait chez nous d'autant plus d'honneur à son inventeur, que, quoiqu'aussi simple qu'il est possible par rapport à la fin à laquelle elle est destinée, il entre dans sa composition un plus grand nombre de parties, et de parties très-différentes entre elles. Nous avons une grande idée du génie de l'ouvrier qui a su réunir et fait concourir à la même fin, autant de parties différentes et nécessaires. Celui qui a fait, les machines animées que nous appelons des insectes, n'a assurément fait entrer dans leur composition que les parties qui devoient y être. Combien, malgré leur petitesse, ces machines nous doivent-elles paroître plus admirables que celle des grands animaux, s'il est certain qu'il entre dans la composition de leur corps beaucoup plus de parties qu'il n'en entre dans celle des corps énormes des éléphants et des baleines! Pour faire paroître au jour un papillon, une mouche, un scarabée, en un mot, tous les insectes, qui ont à subir des transformations, il a fallu au moins faire l'équivalent de deux animaux, faire une chenille dans laquelle le papillon prit tout son accroissement, faire des larves dans lesquelles la mouche et la scarabée pussent croître". Swammerdam is impressed with the same idea. "After an attentive examination (says this writer) of the nature and anatomy of the smallest as well as the largest animals, I cannot help allowing the least an equal or perhaps a superior degree of dignity to the former. If, while we dissect with care the larger animals, we are filled with wonder at the elegant disposition of their parts, to what an height is our astonishment raised, when we discover

all these parts arranged in the least, in the same regular manner! Notwithstanding the smallness of ants, nothing prevents us from preferring them to the larger animals, if we consider either their unwearied diligence, their wonderful strength, or their inimitable propensity to labour."

Another objection, for we shall not term it argument, has been advanced against this study, the validity of which cannot be so thoroughly examined in this place as we could wish; it has been stated, that because insects furnish few of the articles of life they deserve no consideration. This is the language of ignorance, and such as we could easily shew to be of the most futile kind. The study of these creatures is as replete with utility; and the knowledge of them as essential to the benefit of mankind, as most other branches of scientific pursuit; nor shall we scruple to aver, that in this particular respect entomology claims a decided superiority over every other department of zoology. But the fact is evident, that the importance of this science, at least in Britain, has never been duly appreciated, and this arises from the most obvious of all causes, that it has not been sufficiently explained.

Insects may properly be divided into two kinds, those which are either directly or remotely beneficial, or injurious to the purposes of mankind. Many insects, it is true, do not seem to affect us in any manner; but appearances in this respect, let it be observed, are not always to be relied upon. Others, and the number of those is very great, most assuredly fall within the denomination of one or other, and even both the first mentioned kinds, and for this reason ought surely to demand our attention. In the ordinary concerns of life it is deemed of as much, if not greater consequence, to know our enemies, and ascertain the powers of annoyance they possess, as it is to learn what benefit we may be able to derive from our friends: let us apply this plain and rational argument to the study of insects, and we think it will appear equally consistent, when we assert that it is as important to know those which are injurious to our interests, as those which contribute to our advantage. When we are convinced in what respects particular insects have the means of doing us injury, we may guard against their attacks, or apply a remedy to the evil, and if we neglect to obtain those services from the beneficial kinds which they are designed by nature to afford us, it can be no proof of our wisdom.

Left, to the superficial observer, our allusion to the utility of insects should appear theoretical, while the noxious propensities of others may be too fully experienced in the affairs of agriculture, horticulture, and throughout the various branches of domestic economy, to admit of doubt, we shall be more explicit in this observation. The ravages of insects upon vegetation are detrimental to us; but let it be remembered also, that even in these depredations they sometimes repay the injury they commit. The locust itself, the most destructive of all insects, and whose myriads spread desolation through the vegetable world, are not unproductive of advantage, except on some very extraordinary occasions, when their multiplication exceeds all bounds. At other times they deprive mankind of a certain portion of his vegetable food, and, in return, their bodies afford him animal nutriment of a wholesome and palatable kind, and in infinitely greater abundance. The various sorts of locusts are the common food on which the inhabitants of many parts of the world, at particular seasons, chiefly subsist. The honey of bees, both of the wild and domestic kinds, constitute another primary article of food in many warm countries, in the present as in ancient times. The hydromel of the Russians, an excellent and delicious drink, is prepared

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pared from honey, as our beverage is from malt. The various tribes of silk worms, (for of this kind there are several species,) furnish materials for the raiment universally worn by all ranks in the eastern parts of the world, and hence in those countries the silky produce of these industrious little beings is of as much real consequence to them, as the fleecy coat of the sheep is to us the staple article of clothing; as an object of traffic, silk is one of the utmost importance in China and Tartary, and in those parts the paper in common use is also manufactured from the refuse of the same material. The extensive use of wax in all ages is well known; but it is less generally understood that wax is not the produce of the bee alone; the wax insect of China is a very different creature, a species of cicada in the larva state, and which, with the addition of a vegetable oil, forms the mixture of which the candles of that country consist. (Donov. Inf. China.) Certain insects are employed with success in medicine, and a further number might be applied to the same purpose; many others might be also rendered useful in the arts, and lastly, we need only advert to the valuable properties of the different species of cochineal in the art of dyeing, to prove the absurdity of an opinion very generally prevalent among us, that insects are a race of creatures too insignificant to deserve the notice of mankind!

But, were all these benefits unknown; and allowing that the study of insects did not seem to be productive of any substantial advantages, how absurd would it still be to treat such a fair and extensive portion of the creation with neglect. The objection that they are in no manner conducive to our interests, even if founded in truth, would be no evidence of the frivolity of the science itself, unless we are to conclude that the only enquiries which merit the rational attention of mankind, are those which tend to the gratification of selfishness. If this be admitted as a plausible objection, how many objects of philosophical investigation must be rejected as frivolous!

From the earliest period of which any authentic records remain, this race of animals has obtained the attention of every civilized age. The study of these creatures has not assuredly been cultivated with equal ardour at all times, nor has every country produced entomologists of considerable talent. It will be sufficient to shew, that the science itself has never remained in utter neglect, from the remotest period in which the light of natural knowledge dawned upon the intellectual horizon of man. The experience of all ages distinctly proves the charge of frivolity to be inapplicable to this study: many advantages, besides those above enumerated, have been, and continue still to be, derived from this source; and it is furthermore deserving of our observation, that among the number of its votaries in distant periods of the world, we trace the names of the most distinguished characters that adorn the page of history. Perhaps we are at this moment addressing, among the circle of our readers, some at least who, nurtured in habitual indifference towards the subject under discussion, have incautiously fallen into the error of considering it as a trivial pursuit. But we are not without expectation, that even the slight observations which the limits of our paper allow, will direct their attention with more liberality towards this subject, and we shall not hesitate to think in the result of this, they will easily conceive much stronger arguments in its favour than we have adduced. To the idle, or the thoughtless confirmed in prejudice, it would be in vain to offer any reason in its behalf, and to those we shall observe with brevity, that whatever opinion they may be inclined to entertain of its frivolity, the science of entomology will be found in every civilized age and country to have engaged the study of men endowed with talents as

splendid and judgment as refined, as the most exalted for ability among those who affect to treat it unworthily.

These observations opportunely introduce to our consideration a review of those writings which have contributed to enlighten the paths of science in this particular study. The number of these; the value and interest which must unavoidably attach to their contents; and the names of those illustrious characters by whom many of them were produced, will fully sanction, it is presumed, the assurances before advanced. These works, even in point of number alone, we have no doubt will be found infinitely more considerable than most imagine; and this circumstance, independently of any other, tends to prove that we are not singular in our commendation of entomology either as an instructive or useful science; as morally, and intellectually beneficial; for those who write on any subject like the present, must be impressed with some idea of its importance, and these opinions may be collected uniformly from the labours of writers on the study of insects.

As we deem this subject of consequence, it is our decided wish, even in the cursory view to which our limits are restricted, not to omit the mention of any work, however slight, that has been productive of material information. Our strictures, it will be understood, are confined to those we have had sufficient opportunity to consult with some attention; for this we consider due, in candour, to the respective writers whose labours are devoted to the elucidation of science. Sometimes we may be inclined to express ourselves with warmth in favour of merit, neglected, forgotten, mouldering in decay, or which, from latent motives, has never been sufficiently appreciated by later authors. If we err in this, let it be remembered, that in the truth of criticism we oftentimes evince more judgment in bestowing praise, than awarding censure. But we wish it to be explicitly understood, that we do not consider it within our province, at present, to enter at large upon a critical analysis of the multitude of writings before us. Our only object is to point out the existence of the most valuable works that are extant within our own knowledge, describing at the same time the leading intention of their authors respectively: the collateral remarks can be only those immediately incidental to such investigation. The several works enumerated will be adverted to, as nearly as possible, according to the order in which they appeared before the world; and hence our review, however cursory, will be attended with this peculiar advantage, that it will serve to point out the progressive improvements the science has derived from the labours of each succeeding author, in a more perspicuous form than could perhaps be accomplished in any other manner. It will also by this means be found calculated to afford the general reader

### *An Historical view of the Rise, Progress, and Present State of Entomology.*

The destruction of the great public libraries of antiquity has for ever deprived us of the means of ascertaining precisely to what state of perfection this branch of science had attained, till within about two thousand years of the present period. Of those times a few scanty memorials alone remain, sufficient, however, to testify that the study of insects had then made some progress, and was held in estimation. Whatever may be our ideas with regard to still earlier times, it would be needless to obtrude them in this place. We shall observe only, that some books must have been written on the subject before the existence of those which have descended down to us: the reputation of such writings is preserved, and in certain instances the names of authors recorded in the very earliest of those works at present extant,

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which clearly demonstrates the truth of this opinion. Time has not spared the labours of any writer on this subject of more remote date than the third, fourth, and fifth century before the Christian era, and the amount of those which have survived is small indeed; but inconsiderable as they are, in point of number, we may, notwithstanding, collect from them that the study of insects, in those days, held a rank among the liberal pursuits of their philosophers.

We may, indeed, proceed still farther in this retrospect, if the sacred writings of the Hebrews be considered. These abound with passages relating to particular kinds of insects, as the locust, the caterpillar, flies, and vermin. Moses, the earliest of the inspired writers, had probably acquired some knowledge of this subject, in common with the other sciences, from the sages of Egypt; and among the books of Solomon, now lost to the world, it is recorded that he treated on insects, or "creeping things."

Hippocrates flourished in the 80th Olympiad, or fifth century before the Christian era; he wrote on insects, as we are told by Pliny, in whose time some remains of the entomological observations of this celebrated character were probably extant. The writings of the early Greek and Latin writers, quoted by Pliny, afford extracts from this production of his labour.

The succeeding age gave birth to that distinguished natural historian and philosopher Aristotle: the production of whose labour, his history of animals, is worthy of the patronage bestowed on its author by the conqueror of the universe. No one can impartially peruse this inestimable treasure of antiquity without confessing the intimate knowledge its writer must have possessed of the great arcana of nature.

This work of Aristotle is rather of an elementary kind, embracing a general, wide, and comprehensive view of the animated creation, and does not, except on particular occasions, descend to the description of individuals or species. The insect tribe is treated under different points of comparison and view in several parts of the work. In the seventh chapter of his first book, he informs us, that the name *ἕντομα* is generic, or that of a family, and that they constitute one of his four orders of exsanguineous animals, and points out with great accuracy in what respect they differ from the mollusca, crustacea, and testacea, the other three families of this class of animals. By exsanguineous he means only that they have no red blood, for he speaks generally to their bodies being retained in a state of moisture by other fluids. The first chapter of the fourth book affords a definition of the essential character of insects, which consists in the incisions or cuts either on the back or belly, and sometimes on both, by which their bodies appear to be almost divided into two or more parts. But that portion of his work which is more particularly devoted to insects, is entitled *Περὶ τῶν ἕκτο; καὶ ῥίαν τῶν ἐν τούτοις*. In this he more fully describes insects to consist of three parts, the head, trunk, and belly or abdomen; the second part, or trunk, is denominated an intermediate portion, corresponding with the back and breast in other animals; and he also mentions as a character of insects that they are furnished with feet.

The subsequent passages describe different genera, or, as termed, tribes of insects, in which he treats of those which fly and those which walk. Among those furnished with wings, he speaks of some having these parts entirely naked, and others that have them protected by a sheath, or covering, as in the beetle kind: as he furthermore states, that in some beetles these sheaths divide or open when the insect flies, and that in others they are inseparably united. The insects which have naked wings, he observes, possess either four, as in the bee, or two, like the musca or common fly. Some of these

with four naked wings have stings at the end of the body, while beetles, and insects with two naked wings, are destitute of this apparatus; but some of the latter, he tells us, have a proboscis or instrument at the mouth, by means of which they draw blood from other animals. The horns before the eyes (by which he means the antennæ) attract his observation, and those of the papiliones and grylli are particularly described. In his remarks on the different structure of the feet, those formed for leaping are exemplified by those of the locust, and are compared to the posterior feet of springing animals. The humming noise of certain insects in flight, the cruce, and various other circumstances relative to this class of animated beings, have interested the philosopher in this chapter.

The attentive entomologist will feel deeply sensible of the accuracy of every expression, thought, and sentiment, implied in the above-mentioned passages. He will be surprised at their consistency. Their accordance with the entomological definitions of the best modern systematists will excite farther comparison; and in the result of this inquiry it must be obvious, that with the acquired knowledge of two thousand years since his time, so far as he does proceed, we cannot materially amend his observations. This will be admitted; and at the same time we believe even a cursory perusal of the whole work will serve to shew, that whatever might be the merits of Aristotle, and we allow them to be transcendent, these writings evince too much acquaintance with the science of nature, to be the produce of any individual genius shining with unborrowed light. When we reflect upon the slow and gradual progress with which all human knowledge is developed, we are really convinced that the science of nature must have made some considerable advancements before his time; and that he has derived many eminent advantages from consulting the works of more ancient naturalists: men whose original labours have been lost to posterity for ages, and the only traces of which at present extant are to be found embodied in his pages.

Ælian, in his work on animals, ΠΕΡΙ ΖΩΩΝ ΙΔΙΟΤΗΤΟΣ, appropriates several detached chapters to particular kinds of insects, without entering in a methodical manner into the history of the tribe. Those he does include are described with attention: as, for instance, the scorpions, *Σκορπίων*; ants, *Μυρμηκῶν*; spiders, *Ἄραχνα*; crickets, *Τετρίγων*; the generation of wasps, *Περί τῆς Σφηκῶν γενέσεως*; of cantharides, *τῶν καλέων Κανθαριδῶν*, &c.

The Greek poet Phile, called also, from his superior knowledge of natural history, "Phile Sapientissimi," introduces some pleasing poetical effusions relative to insects among his poems on animals. The manners of the cicada, and the bees, *τετρίγων*, and *μελισσῶν*, are very prettily described in verse by this writer. He entertains the same idea as Ælian, that the cicada, by which he means the cricket, (not the insect named cicada by Linnæus,) lived on dew; and that the female was mute, while the male "enchanted the grove with the harmony of song." He speaks also of the lampyris, and various other insects. The beautiful ode of Anacreon to the cicada is familiar to many.

Among the Greek writers who immediately, or within a few centuries after, followed Aristotle in treating upon insects, were Democritus, Neoptolemus, Aristomachus, Philistus, Nicander, Meneceates, Dionysius Mago, Empedocles, Callimachus, Attalus, Apollodorus, Eriphilus, Erasistratus, Asclepius, Themiso, Posidonius the stoic, Meander of Priene, Euphronius of Athens, and Meander of Heraclea, Theophrastus, and Hesodius. These were authors after the time of Aristotle, and preceding or contemporary with Pliny. The Latin writers, during the

same interval, were also numerous, and appear to have been influenced to pursue this study in imitation of the Greeks, or were insensibly led into it from attending to the culture of bees. The most eminent among the latter were M. Varro, Hyginus, Scropha, Sarcana, Celsus Cornelius, Æmilius Macer, Virgil, Columella, Julius Aquila, Tarquilius, Umbritius, Cato Censorius, Domitius, Calvius, Trogus, Melissus, Favonius, Fabianus, Mutianus, Nigidius, Manilius, and Opius. The cultivation of bees was attended to in those times with the most enthusiastic ardour, and their history detailed by many eminent writers. We are told that Aristamachus of Soli wrote upon this subject, from the result of sixty years experience; and that Philiscus the Thasian acquired the name of Agrius, from having employed his whole life in forests and deserts, attending to these insects. The culture of silk-worms was another favourite object with the ancients, as we learn from Pliny, who relates that in his days garments of silk were greatly admired by the fair sex, because, from the delicacy of its texture, it displayed the beauty of their persons almost as distinctly as though they were naked.

The eleventh book of Pliny treats of insects, as the most subtle of all animals in nature. He speaks of those which fly; some with naked wings, and others with wings protected by a covering, as Aristotle had previously observed. The bees, wasps, hornets, spiders, grasshoppers, locusts, ants, &c. are among the number of insects described by this writer.

From the time of Pliny till the overthrow of the Roman empire, a period of several centuries, the science of insects seems to have made some progress, though to what extent we may probably never learn. The names of writers in those times, and some few scattered memorials of their labours, are to be found recorded in the voluminous works of authors that appeared at the revival of learning in the sixteenth and following century. The number of these could not have been very inconsiderable: among the principal of them were Ætius, Paulus Ægineta, Alexander, Trallian, and Oribasius.

The last-mentioned authors lived between the fourth and seventh century. After this time, through the dark ages, while ignorance in every science prevailed nearly over the whole world, this study might have been little attended to. But we are not to conclude that even during this time it was utterly neglected. Learning had then taken a retrograde course from Greece and Rome towards those eastern regions, from whence they had originally emanated; and the sciences, during this interval, were cultivated with some success in Arabia. The advancement made by the Arabians in the study of botany, between the ninth and twelfth century, is known to have been rather considerable. Among the entomologists of those ages we recognize some of those Arabian botanists; several of whom were distinguished for their acquaintance with plants, as Rhazes, Avicenna, Avenzoar, and Averrhoes, each of whom wrote on insects.

From the twelfth to the fifteenth century, a darker period than the preceding, there are few writers on this subject. The principal of those, at least within our knowledge, during this period, are Myreplus, Hildegardis, Platerus, Arnoldus de Villa Nova, and Petrus Crescentienus. There are a few others, but they are too obscure to deserve mention.

Some part of the general zoological work of Albertus Magnus, "De Animalibus," &c. relates to insects. Its author was bishop of Ratisbon, and died in 1280; but his work, which is written in the Latin tongue, and was printed at Venice, did not appear till the year 1519.

In 1549, the work of Agricola, entitled, "De Animalibus subterraneis," made its appearance; and in this we find one of the earliest systematic arrangements of insects extant. This author reduces all insects to three principal classes, namely, \*those which walk, \*\*those which fly, and \*\*\*those which swim; and under each class describes a number of species.

About the middle of the same century, Edward Wotton, a doctor of medicine in London, published "De Differentiis Animalium;" a work relating, among other tribes of animals, to that of insects, a science in which its author excelled. This work is in folio, and bears date 1552; from which it must have appeared three years before the author's death, which happened in 1555.

The work of Rondeletius of Montpellier, "Libri de Piscibus Marinis," published in 1555, or rather earlier, treats, as the title intimates, on fishes, and other aquatic animals; to which, however, it is not entirely confined; for he also speaks of insects, and even accompanies some of his descriptions of these insects with figures cut on wood. Lesser mentions that in the library of the Jesuits at Ratisbon, there is a copy of this work in two volumes; on the margins of the leaves of which are large notes, said to be in the hand-writing of Gesner. Whether these notes have in any manner appeared before the public we know not: the circumstance is repeated only for the purpose of inquiry. If Lesser afforded any intimation of the nature of those notes, we might ascertain whether they are the same with the observations of Gesner on Rondeletius, in his "Historia Animalium," an edition of which we suspect was printed soon after the work of Rondeletius appeared.

Conrad Gesner, esteemed the most diligent inquirer into nature which his age produced, and who, in reward for his assiduity, obtained the title of the German Pliny, has treated slightly on insects in that part of his work which relates to the nature of serpents, "De Serpentina Natura," &c. printed in 1587. His discourse is chiefly concerning the scorpion tribe. Some tracts of this author appear to have been published so late as 1620; neither of these, however, are on the subject of entomology.

A far more voluminous work than either of the foregoing was produced by the industrious and learned Aldrovandus, in 1602; a folio volume of several hundred pages, with the title "De Animalibus Insectis," and forming part of his grand work on animals. Aldrovandus has not escaped censure. In the "Amœnitates Academicæ," Forstal considers him as an indefatigable compiler, celebrated for the number of his works, but who thought he had acquitted himself in collecting together the undigested observations of the ancients. We cannot avoid expressing other sentiments; and notwithstanding that he has fallen into many errors of his predecessors, this work entitles his memory to respect. Aldrovandus was not merely a compiler; he availed himself of the labours of former writers, and in this respect with less servility, and certainly with more candour, than many who advance this objection against him: for he generally refers to his authorities. Aldrovandus was professor of medicine in the university of Bologna, and, according to his biographers, the study of insects was his favourite object. In this pursuit he expended large sums of money, travelling for information, and in the employment of artists; as he was unfortunately, like some other eminent naturalists, himself deficient in the talent of drawing. During the space of thirty years, he paid two hundred florins annually to a painter, solely occupied in the delineation of insects for him. From the fatigue of his researches, this indefatigable naturalist was unhappily deprived of sight in his old age.

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In his classification of insects, he divided all these animals into two primary orders, the terrestrial and the aquatic; the first called *favica*, the other *non-favica*. These two classes are subdivided into many orders; the characters of which are determined by the number, nature, and position of the wings and feet.

The representations of the insect tribes, from their inferiority of size, added to the general minuteness of their characters, are rather more rudely expressed in the work of Aldrovandus, than the figures of the larger animals, which these volumes contain. A defect of this kind is less excusable, because from the liberality of Aldrovandus towards his artist it might not be expected; and furthermore, because about that period a better taste, and a desire for more expensive embellishments in works of this description, began to prevail. The graphic art, or engraving on copper, though scarcely emerged from infancy, was now introduced in aid of this science, in preference to cuts on wood, and with no small success, as we observe in the works of Hoefnagle, Hollar, and others of that period, whose labours are well known. Those embellishments, though greatly admired in their time, were, however, too costly to be introduced into works of the ordinary kind; they were confined to the more expensive productions, and, indeed, almost exclusively to those produced by artists themselves; for we seldom meet with them in any work of which the artist is not also the author. The best book of that period in our own country, for such we consider Mouffet's "*Insectorum Theatrum*," affords only cuts on wood, an instance sufficiently corroborative, as this work was printed in 1634. Even for the space of nearly a century after this, copperplate engravings were sparingly introduced. The learned Lister, in his edition of the works of Geodartius, so lately as 1682, laments the great expence of engravings, at the same time that he expresses his conviction that they are indispensable in works of this kind. "I have taken great care of the designs," says this writer, "in transferring them upon copper-plates, which I dare promise are exquisitely performed by the best of our English artists, which was at my expence; and the booksellers were not willing to reimburse me."—"And upon this occasion I must needs say, that natural history is much injured, through the little encouragement which is given to the artist, whose noble performances can never be enough rewarded; being not only necessary, but the very beauty and life of this kind of learning." But, to resume the course of our subject in historic order, the next work immediately in succession to Aldrovandus is that of Wolfgang Frenzius, published in 1612, and called "*Historia Animalium Sacra*," a valuable work, as containing much original observation. After the manner of Agricola, he distributes all insects into three classes, which he names *aërea*, *aquatica*, and *terrea et reptantia*. A small octavo, printed three years after, though a slight production, should be mentioned in this place; it is a treatise on ants, a pamphlet of about one hundred pages, and is written in Latin; the title "*De formica*," &c. by Jeremiah Wilde. The work of Fabius Columna, "*Aquatilium et Terrestrium aliquot Animalium Observationes*," printed at Rome in 1616, relates also, in some degree, to insects; and finally, in point of precedence to Hoefnagle, we have to notice another, a work of some moment, that appeared soon after, from the pen of Archibald Simpson: this was published in North Britain, and from the motives of the author and singularity of its contents claims explicit mention. From the title of this book, which is sufficiently explanatory, it will be perceived that entomology was only a remote object in the mind of the writer. The work de-

rives its greatest share of interest, in our present view; from being one of the first publications connected with the study of insects printed in Britain. This book, which is in quarto, was printed at Edinburgh in the year 1622, and bears the following title: "*Hieroglyphica Animalium terrestrium, volatilium, natatilium, reptilium, insectorum, vegetivorum, metallorum, lapidum, &c. quæ in Scripturis Sacris inveniuntur et pluriorum aliorum, cum eorum interpretationibus.*"

At length our enquiry arrives at that particular period when the painting of insects was esteemed suitable and worthy of the pencil of the most skilful artists of the age, the painters retained with magnificent salaries in the courts of princes, and in the most polished states of Europe. Under the fostering influence of such patronage, it ought not to excite surprise that some advancement was made in this branch of the art. For our own part, we are not impressed with any very high opinion of the talents evinced in depicting these pleasing objects, at least by some of the artists thus employed. With such inducements for the exertion of genius, and with the reward and credit naturally attached to their productions, they ought certainly to have succeeded better. But though the arts derived no very material advancement from their attention to this subject, to the cause of science their assiduities were productive of infinite benefit. The cultivation of exotic plants, which about that time began to be held in proper estimation, afforded an ample field to those artists whose labours were dedicated to the task of portraying these pleasing objects. Their great forte prevailed in painting flowers, and though insects offered for many charms of attraction, they appear at first to have been only introduced occasionally, and as secondary objects, to their pictures. These embellishments were attended with success in proportion to their fidelity, force, and truth. In a state of nature these lively creatures are constantly seen sporting about the unfolding blossoms of the vegetable creation in search of their nectareous sustenance, and their introduction could not fail to infuse a spirit of ideal animation into their best performances. Hence it seems, that insects were afterwards represented in their compositions with a less sparing hand; and, in the course of time, became with many artists the principal, instead of secondary object of imitation. Thus also, from casual observers, those artists were progressively led to a more intimate acquaintance with these creatures, and to an inquiry into their history, the novelty of which may be perceived to have amply gratified their curiosity, and rewarded their application. Their example fortunately inspired a congenial taste among their patrons, and hence, in the space of a few years, a new and more propitious era seemed to dawn upon the science of insects. The study was by this means promoted, and rendered an object of attention among the higher orders connected with the most enlightened courts of Europe; as for instance, that of France, the imperial court of Germany, and those of the princes of the empire.

An observation of the celebrated Jussieu in the beginning of the last century is altogether applicable to this investigation. "The arts and sciences," says this writer, "owe their perfection to circumstances which may appear the effect of chance," and the truth of this remark is completely verified in this particular instance; for, it must be recollected that the art of embroidery, a mechanical process, and which in our days is superseded by the more dignified production of the pencil, is that which called forth the talents of the painter to the delineation of natural objects in the age adverted to. It was to the improvement of embroidery that his merits were at first subservient; or at all events to a peculiar train of cir-

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circumstances arising originally from this cause, that we are to ascribe the progress made in this branch of the profession, from the close of the sixteenth till the middle of the succeeding century. About the reign of Henry IV. and Lewis XIII. of France, embroidery was in the zenith of fashion, for the decoration of magnificent furniture, and drawings of the most beautiful plants were made expressly for the embroiderer's imitation. The obligation which botany lies under to this cause is well known, and that of entomology during the same period, if attentively considered, will be found no less conspicuous.

The painters eminent for their abilities in this line, were Hoefnagle, Robert, Aubriet, De Bry, Vallet, and Robin. There were others to whom we shall advert more particularly afterwards. In order to demonstrate the benefit which botany derived from the labours of such artists, it need only be mentioned, that the celebrated Tournefort founded and arranged his system of plants upon the drawings made by Robert and Aubriet for the royal library of France. The other artists alluded to were still more conversant with the science of insects than the former, and their labours of their pen have contributed, in unison with their pencil, to promote this species of knowledge. Some especially were very successful in this respect.

Merian, Admiral, Schwertz, and Goedart, and also our own countryman Albin, were among the number of those most eminent for their acquaintance with the history of insects; and, were this list to be augmented with the names of other artists of somewhat later date, who have likewise distinguished themselves in the same manner, the result would testify that entomology, like many other branches of natural history, is greatly indebted for its advancement to this class of authors. It is from the works of the artist, or of those who by their application have rendered themselves competent to delineate the objects they describe, that the most valuable information has been obtained. The works of Rösel will sufficiently testify the truth of this observation, but were any other confirmation necessary, we would advert to Lyonet, who, though not an artist by profession, felt proudly conscious of his superiority as a naturalist, because from perseverance he had acquired the talents of an artist. Are they not the imitative labours of this class that furnish ample materials for the productions of those who are mere describers: writers, who oftentimes like hornets enter the hives of industry, and plunder without molestation?

The work of Hoefnagle, a thin volume in 4to. was published in 1630, under the title of "*Diversæ Insectorum volatiliū icones ad vivum depictæ per D. J. Hoefnagle, typifque mandatæ a Nicolao Joannis Vifcher.*"

The plates altogether contain figures to the amount of three hundred and twenty-six. The execution of these acquired the artist no small share of celebrity, yet it must be acknowledged that they are not invariably deserving of approbation; some at least are very indifferent. Hoefnagle does not adopt any particular mode of arrangement, and he contented himself with representing the insects in the states in which chance presented them, without always following them through their progressive changes.

Only four years elapsed after this volume of Hoefnagle's plates were brought forward, before another production of infinitely greater consequence as a work of science appeared in our own capital, namely, the entomological work of Thomas Moufet. This, as it professes to be, is an improvement on the work of Dr. Wotton, begun in the year 1550, about five years before his death: it was continued by Conrad Gesner, was afterwards enriched, as it is expressed by Thomas Penny, and at length assumed the improved form

in which it was published in 1634, from the hands of Moufet. This last mentioned editor revised the order of its arrangement, corrected and enlarged the descriptive matter, and embellished its pages with nearly five hundred wood-cuts, the greater portion of which, though rudely executed, are not destitute of merit. The work is intitled "*Insectorum five minimorum animalium theatrum: olim ab Edoardo Wottono, Conrado Gesnero, Thomaque Pennio inchoatum: tandem Tho. Moufet Londinatis operâ sumptibusque; maximis concinnatum auctum, perfectum: et ad vivum expressis iconibus supra quingentis illustratum.*" This author divides his work into two parts, the first containing twenty-nine chapters, the latter forty-two, under which he respectively describes the several tribes of insects, known among the early writers by the names of vespis, muscis, papilionibus, cicindela, blattis, cantharide, buprestis, meloe, &c. terms familiarized to the Linnæan scholar, but which are not always applied by Linnæus to the particular tribes of insects, designated by these names in the work of Moufet and his predecessors: a fault we trust to see one day amended.

Hollar gained considerable reputation by his iconical work, "*Mulcarum, Scarabeorum Vermiumque variæ figuræ et formæ omnes primo ad vivum coloribus depictæ et ex collectione Arundeliana,*" &c. published at Antwerp in the year 1646. The drawings were preserved in the Arundel cabinet; the plates are etchings in the usual style of its author.

About an hundred and fifty pages of the extensive work of J. Jonston, "*Historia Naturalis*" is devoted to the subject of insects, which tribes he distributes into four books, the first of which treats on terrestrial insects provided with legs and wings, the second of terrestrial insects which have feet and no wings, the third of the terrestrial apodal order, and the fourth of aquatic insects. These are illustrated by twenty-eight plates engraved on copper by the author, who was doctor in medicine.

Few authors are condemned with more critical severity than Jonston; his work is certainly a compilation, and as it has been stated, his materials are mostly taken from the works of Aldrovandus, Moufet, and others. Forskal denominates him a persevering compiler, and at the same time observes that he has not added a single remark to what was before discovered. These observations appear in the "*Amœnitates Academicæ,*" in which there is also another paper by Bladh, where we find the same sentiments repeated: The opinion thus expressed is known to have the sanction of Linnæus. This deficiency in the arts, to which he aspired, is warmly censured by Lyonet, who declares his butterflies to be of unsufferable deformity, and in form, or outline, to be constantly alike in all the figures. As an artist, nevertheless, he had his admirers: if we can place any reliance on the truth of his biographers, he was not destitute of ability. Moncoyons says, he saw in the hand of Mr. Plater of Basil a set of drawings executed by him with tolerable accuracy. And Lesser himself owns that many years ago he was shewn others very prettily painted by him on blue paper, in the possession of a nobleman belonging to the household of one of the kings of Poland.

The work of Jonston, which is in folio, and dated 1657, was published at Amsterdam. In the year following, we meet with an English translation of Moufet's work, printed by Topf, chaplain of St. Botolph's, in London. Nearly about the same time the work of Goedart, a Flemish painter, made its appearance in Holland in the language of that country. The last mentioned production deserves more explicit mention, for we think its merits have never been very candidly

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estimated. The engravings are described as of miserable execution, and the figures so indifferent in point of resemblance to the objects intended, that they could only in particular instances be understood; and again, on the contrary, the details are represented as so defective, that unless accompanied by his valuable plates, they would be useless. So much is advanced by his various annotators, and yet with all these imperfections, those individuals have condescended at different times to favour the world with translations of his work, originally written in Dutch, into the Latin, French, German, and English; and with various editions of the plates also. The truth is, that Goedart was a painter; the mere describers, from unworthy motives, were offended that he should presume to write, while they professed to be enraptured with his talents in the arts; and the artists denied him praise because they considered him as a naturalist, not a painter. Were this work of Goedart the production of our days, it would be undeserving of comment; but let us consider the period in which it was produced, and abating our expectation of excellence in those times either in the accuracy of observation, the history of insects, the style of language, or correctness of design; and we must acknowledge it in every respect as a valuable performance. The best of his annotators, even the ingenious Lister, to whom the original work was certainly under most obligation, has committed several errors in endeavouring to correct him.

For the space of about twenty years Goedart devoted great attention to the study of insects. He followed them through their progressive changes with great precision: this renders his book more extensively acceptable, and his figures, which have never been surpassed by his predecessors, are for the most part so far correct as to be understood. The Dutch edition of Goedart's work being soon sold off, the first volume of a Latin translation, by Dr. Mey, minister of Middleburgh, was brought forward under the title of "Metamorphoses et Historia Naturalis Insectorum," in the year 1662; and a second volume also, in the same language, translated by M. P. Veezaerdt, minister in Zealand, who added thereto some remarks of his own. Another translation of this latter part was afterwards published by Dr. Mey, with a farther addition of notes. Lister allows those annotators no credit for their labours; Goedart, he observes, left his writings in Dutch; "His Latin interpreters," says he, "have added comments indeed, but were men wholly ignorant in natural history, and their comments are mere rhapsodies, and altogether impertinent to the explication of any one history of Goedartius." Dr. Lister re-arranged and corrected this work, and added at the same time many curious observations.

A history of animals and minerals, in the course of which the subject of insects is noticed at some length, appeared in London in 1661, under the title of "Πανζωοριχτολογία."

The invention of the microscope opened to the curious a new opportunity of penetrating into the mysteries of nature, and discriminating with accuracy the most delicate organs of the minor tribes of animals, which from their minuteness had evaded observation before, and among these the insect race alone constituted such a vast proportion, that we may attribute to this cause that spirit and perseverance with which the study of these minute bodies was pursued about this particular period, and for the space of some years after. The era of this invention is ascribed to the year 1680, and although this does not appear to be strictly accurate, since an apparatus corresponding with it was in use at the earlier date of 1618, and that glasses possessing the power of enlarging the appearance of objects very considerably were

known among the ancients; yet, upon the whole, it may be concluded, that what is now understood by the microscopical instrument, received so much improvement about the time first mentioned, that, in qualified terms, we must date its invention from that period. The discoveries made by the assistance of the microscope within a few years after this time renders it a memorable epoch in the science of natural history, and so far as relates to insects, it is probably owing to the introduction of this valuable instrument into general use, that the names of Hooke, Power, Pierre Borel, Bonomo, Antoine Van Leuwenhöek, Joblot, and Hartsoecker (the latter of whom detected the circulation of the fluids in insects); and many other inquisitive individuals appear in the list of entomological physiologists, or anatomists.

The work of Power is in quarto, and was printed in 1654; this relates slightly to insects as objects of microscopical investigation. Hooke's "Micrographia" appeared the year after, and treats of insects in the same view. In the memoirs of the French Academy of Sciences in Paris, for 1666, there are some entomological observations by Mignot de la Voye; and in the fifth volume of the Philosophical Transactions a paper relating to "insects lodging themselves in willows," by King and Willughby. But the letters of Lister, which also appeared about the same time, or within the course of five or six years after, are still more valuable; among these are "letters concerning a fly that is viviparous, and concerning an insect feeding on henbain." "A considerable account touching vegetable excrescencies;" "Letters about musk-scented insects, vegetable excrescencies, and ichneumon-worms;" "A Letter containing the projection of the threads of Spiders, and Bees breeding in cases made of leaves, a viviparous fly, &c."

A small number of the insects indigenous to Britain is described by Christopher Merret, in his "Pinax rerum naturalium Britannicarum," &c. published at London in the year 1667.

An account of the tarantula engaged the pen of Wolfertus Sanguerdus (a medical professor) about the middle of this century; his work, entitled "Tractatus physicus de Tarantula," appeared in the year 1668; it is a small duodecimo of seventy pages, and was printed at Lyons. The general work of an English entomologist, Charleton, was the same year published in London, under the title of "Onomasticon Zoicon, pluriorumque animalium differentias et nomina propria pluribus linguis exponens," in which we have a systematic arrangement of insects after the manner of Aldrovandus. There is a mantissa of this work printed in folio in Oxford, in 1677.

Another work on entomology, a treatise professedly elementary, was published at Leipsic, the year after the first part of Charleton's work appeared. It is in quarto, and is entitled "Dissertatio de Insectis in Genere," &c. Jacob Wolff, professor of medicine at Jena, was the author.

Redi's "Experimenta circa Generationem Insectorum," for the time in which it appears (1671), is an intersting little book. Its author combats the doctrine of equivocal generation, maintained among the ancient philosophers; and deduces its fallacy from a variety of experiments and observations of great critical accuracy; in the course of which he demonstrates that every living creature is produced from an egg. The same work contains about thirty figures of the lice peculiar to particular birds, such as the pigeon, swan, pie, heron, &c. The same writer also published his work on the generation of insects in his native language, "Esperienze in torno alla Generazione degl' Insetti," 1688. There are several useful tracts by Redi on natural history;

history; but the above-mentioned is that which principally relates to entomology.

Another curious work, " *Experienze intorno alla Generazione dellè Zanzare,*" a small tract of about twenty pages, and embellished with one plate, was published in 1679. It is entirely confined, as the title implies, to the common gnat (*Culex pipiens*), and is written by F. P. Sangallo.

A writer, whose celebrity for his anatomical knowledge of insects can never be erased, while the science itself continues to be respected, is the next in order for our consideration: this is the indefatigable Swammerdam. One of the most important works of this acute observer of nature, his general history of insects, bears date 1669. We allude to the first edition printed at Utrecht, in the Dutch language, under a Latin title, "*Historia Insectorum Generalis; ofte algemeenvver handeling van de bloedeloose Dierkens.*" Of this work it has been well observed by a German critic, that it has no other fault than that of being written in a language not generally known. The work, in this original state, is in the quarto form, comprising rather more than two hundred pages, and is illustrated by figures contained in thirteen copper-plate engravings.

Some years passed away before the excellence of this work, the admiration of the learned in later times, was in any manner acknowledged; and the fate of Swammerdam, a man who, in the generosity of his mind, had exhausted the greater portion of his life in the completion of a work, so wisely calculated to enlarge the boundaries of human knowledge, affords another and very striking instance of genuine worth neglected:—another example of that culpable spirit of ingratitude which living merit so rarely fails to experience, in reward for the most splendid services their talents confer upon an illiberal world!—Chilling thought! that gloomy reflection which oftentimes suppresses the bright, the enviable, but too fatal exertions of genius, and shrouds the mind in apathy and indifference! No sooner was the death of Swammerdam announced, than his merits were discovered; and an anonymous translator rendered his book into French. Almost immediately after, another appeared in Latin; and after some time, another in English: all which contributed, but too late, to the author's fame. He died in 1680. The first French translation is dated 1682, and, like the original, is in quarto, and embellished with plates. The Latin translation corresponds with the two preceding, except that Hennius, in a second edition of the Latin copies, enlarged one chapter which treats on the analogy between insects and other animals and plants. The first Latin edition, "*Historia Generalis Insectorum, Latinam fecit H. C. Henninus,*" was printed at Lyons in 1685; the augmented copy in 1693, at Utrecht. The English translation is by Thomas Flloyd, and is printed with the edition of the "*Biblia Naturæ,*" in our own language, published in London, in 1758.

The latter work of Swammerdam was introduced to the public under very extraordinary circumstances. Such was the ill success of his former writings, that the "*Biblia Naturæ,*" after being prepared in manuscript for press, was left unpublished. No bookseller would venture to print it at his own risk; and the means of Swammerdam were inadequate to its production. At the death of the writer, M. Thevenot, his friend, became possessed of his papers, and with the copy of this among the rest. With him they remained some time, and then passed into the hands of Du Verney, an able anatomist, who enriched his own cabinet with the manuscript of this work. With him it lay buried, till the zealous and illustrious Boerhaave purchased them; and he was no sooner possessed of it than he hastened to

communicate this treasure to the world, and it was accordingly put to press in 1736. He included in this publication the former works of the author, and published the whole under the title of "*Biblia Naturæ, sive Historia Insectorum Belgicæ, cum Versione Latina H. D. Gaubii, et Vita Auctoris per H. Boerhaave.*" This work is in folio: the first volume, consisting of five hundred and fifty pages, appeared in 1737; and the second volume, of much greater bulk, and with many plates, in the year following.

The system proposed by the author of this work, for the arrangement of insects, differs so materially from that given by any preceding author, that we cannot avoid considering it immediately relevant to our present subject. The general or principal classes into which insects are divided in his system amount to four; and the characters of these relate to the metamorphoses the insects undergo, rather than to their appearance in the perfect state, the first class excepted.

The first of these four classes comprehends those subject to no change of form, but which quit the egg in the same state and appearance they are to retain during life. This class includes spiders, onisci, &c.; and must be therefore understood as admitting of an increase in bulk, though not undergoing any change in form.

The second class includes those which, after leaving the egg, appear under the form of an insect without wings, the other members formed; in which state it eats and grows, till, having passed into the second or nymph state, it issues from thence with wings, and is in a condition capable of propagating its kind. The locusts and dragon-flies are included by its author in this class.

In the third class, the animal, after having issued from the egg, where it remained in a disguised state, and without food, appears under that of an insect which eats and grows, while the members of the animal into which it is to be converted are formed under the skin, and which it at last quits, and becomes a nymph or chrysalis (of the dormant kind). This class includes moths and butterflies, &c.

The fourth class consists of those which, having arrived at the nymph state, like those before mentioned, do not divest themselves of the skin, in order to enter into that state, but assume the form of the nymph under its skin, where it continues shut up, till, quitting two skins at once, it comes forth in the perfect state. The insects of this class, according to its writer, are exemplified in the ichneumon.

There are some few small tracts published by this author during his life, neither of which is of material consequence, except that on the natural history and anatomy of the ephemera horaria, "*Ephemeræ Vita, of afbeeldingh van 's menschen leven, vertoont in de Historie van het uligent ende een-daghevent Haft of Oever-aas,*" a work in octavo, printed at Amsterdam in 1675. Immediately after the author's decease, namely in 1681, there were no less than two translations of this work; one in quarto, in English, and printed at London; the other by M. Thevenot, at Paris.

No work materially important on the subject of entomology appeared after the first edition of the work of Swammerdam, till the years 1678 and 1679, in which Lister published his valuable history of English spiders, and Madame Meriau her extensive work on the metamorphoses of lepidopterous insects. In the interval between there were several publications, which, though not of the most valuable kind, are sufficiently interesting to claim remark. Claude Perrault, one of the ablest writers on exotic insects of his age, and author of several papers in the *Memoirs of the French Academy*, produced a work in folio at Paris, in 1671, which

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treats on insects, under the title of "Memoirs pour servir à l'Histoire naturelle des Animaux;" and to this some additions were made in 1676. The work of Ferraud of Naples also relates to insects, among other animals; and this appeared in 1672. The year after Frenzelio submitted his "Insecta novifolia cum nive delapsa;" and at Franckfort on the Main, D. W. Mollerus brought forward his "Meditatio de Insectis quibusdam Hungaricis prodigiosis anno proxime præterito, ex aère una cum nive in agros delapsis," an useful treatise of 120 pages, with two wood cuts. In 1675, George Berelio printed at Upsal his elementary tract, *περί τῶν ἰνσέκτων*. The same year also, Samuel Bochart published his "Hierozoicon, sive bipartitum Opus de Animalibus sanctæ Scripturæ." Müller, in 1676, gave an orationary paper on the tarantula spider, "Dissertatio de Tarantula;" and Hermannus Grube, a curious little octavo volume on the same subject, "De Tarantula, et vi Mulices in ejus curatione, conjecturæ physico-medicæ."

Dr. Lister distinguished himself in the annals of entomology about this period. Previous to the publication of his "Historia Animalium Angliæ Tractatus de Araneis," several papers by this author appeared in the Philosophical Transactions, the principal of which relate to this tribe of creatures; such as his observations on the darting of spiders, in the fourth and fifth volume; his paper entitled, "Some Inquiries concerning Spiders;" and his "Tabulæ compendiariz Araneorum Angliæ," in the sixth volume. Lister's work on spiders, before mentioned, relates chiefly to those indigenous in England, and are arranged and designated by concise specific characters with much science, corresponding with that adopted afterwards by Linnæus. This is in quarto, and was printed at London in 1678; the appendix, "De Araneis addenda et emendanda," &c. in 1681. There is a translation of this work in the German language, by F. W. H. Martini, printed in 1778.

We are in possession of the first translation of the works of Goedart by Lister, a book printed at York in 1682, under the following title, "Johannes Goedartius of insects, done into English and methodized, with the addition of notes; the figures etched upon copper by Mr. F. Pl." The name of Lister does not appear; but the initials at the close of the address to the reader are M. L.; and in our copy, the letter L is rendered Lister, in the hand-writing of an entomological collector well known in the earlier part of the last century. The latter circumstance, though not apparently of much moment, is related because the fact might admit of doubt, the work being anonymous, and perhaps forgotten. The impression consisted, as the preface acquaints us, but of 150 copies, which were intended only for the curious; and in the course of nearly 130 years, it may be naturally concluded many of these must have been lost. The notes in this book are very copious. In 1685, an edition of Goedart by Lister appeared in Latin. The translator in this, as in the former work, distributes the materials of Goedart's performances into a new form of arrangement, the merits of which are too obvious not to be considered as an improvement on the original production. He divides them altogether into ten sections; for they are not strictly, in every instance, what we might denominate orders; in some they certainly are. The first, second, and third sections are of the lepidoptera kind, and very clearly discriminate the papiliones from the moth tribe.

The 1st includes those with erect wings; these are the butterflies which fly by day, and the chrysalids of which are angular.

2d. Moths with the wings placed horizontally, and which proceed from the caterpillars called geometræ by

Goedart, because of their gait, which is like that of a measurer of land.

3d. Moths with dejected wings, or those with hanging wings fitting closer to the body than in either of the two preceding.

4th. Libellulæ, or dragon flies.

5th. Bees.

6th. Beetles.

7th. Grafshoppers.

8th. Dipterous flies.

9th. Millepedes.

10th. Spiders.

Goedart spent forty years of his life, as he expresses it, "daily conversing with insects;" and from the course of his observations, it is manifest he was well acquainted with his subject. Lister is nevertheless unwilling to concede this point: he neither allows him credit as a naturalist or a writer, at the same time that he extols his excellent skill in limning. These opinions are delivered in a style of affected superiority over his author, neither becoming, nor strictly true; and seem to be dictated so nearly in the spirit of some more modern critics, that one cannot avoid smiling at the comparison. "Goedart," says he, "after forty years attention, seems to have made little advancement in his skill in the nature of insects: he seems rather to have diverted himself with them, than to have given himself any trouble to understand them; and yet after all, you will find him every where very just, and true in his observations, but in many places very short, and hardly intelligible." Our English annotator gained no reputation on the continent for these general remarks, although the merit of his notes relating to the metamorphoses of insects was acknowledged; the works of Goedart still maintained their credit.

Maria Sybilla Merian, vel Gräffinn, the wife of John Andrew Gräffinn, was a native of Franckfort on the Main, and early in life imbibed a taste for the study of insects, from being occupied at times in painting these pleasing objects as embellishments to her flower-pieces. The task of painting insects was performed by this fair artist with no very falliduous share of accuracy. In point of drawing she rarely excels; and her productions, though splendid memorials of her talents, and the great encouragement she obtained, are marked by a peculiar exuberance of style incompatible with any faithful resemblance of nature. Her first work was published in 1679, and relates to European insects, chiefly those of the lepidopterous order, with their changes, and is entitled "Der Raupen wunderbare verwandelung, und sonderbare blumen-nahrung;" another part appeared in 1683. These were published at Nuremberg. In 1718, another work by the same authoress was published at Amsterdam, called "Erucarum ortus, Alimentum et Paradoxa Metamorphosis." After this we have an history of the European insects, rendered from the Dutch text of Madame Merian into French, with an augmentation of the description of the plants by J. Marvet, a work printed in folio at Amsterdam, in 1730. But the best of all her publications came out at the Hague in 1726, in a folio of superior size, with the title "De Generatione et Metamorphosis Insectorum Surinamensium," &c.; the materials for which were collected by herself, or under her own inspection in Surinam. This lady had made a voyage from Holland to South America in 1699, for the avowed purpose of forming a collection of natural curiosities for this work, and was occupied at Surinam during the space of two years in taking drawings and descriptions of various objects for this purpose. This work is not entirely devoted to entomology, as, besides insects, it contains a miscellaneous

lineous assemblage of toads, lizards, serpents, and other reptiles, and likewise a pretty extensive number of plants.

In the Philosophical Transactions are to be found some observations concerning insects, made in Virginia in 1680, with remarks by J. Petiver. Hoppio, in 1682, published at Jena a dissertation on the gryllus migratorius. Two years after, another small tract appeared also at Jena, a paper on ants, "Respublica Formicarum," by A. Schmidt.

The fifteenth volume of the Philosophical Transactions affords an account of the "Connough-worm," by Wm. Molyneux, a paper afterwards translated into Latin, and inserted in one of the continental journals under the title of "Observatio de Insecto Hibernico vocato Connough-worm." Some few entomological observations of a miscellaneous nature, extracted from the manuscript history of Pembroke-shire by George Owen of Henllys, lord of Kemmes, occurs in the eighteenth volume of the same Transactions. The original MS. of this history we have seen in the British Museum. Besides the above, the Transactions about the same time contain several interesting papers relative to insects; as Allen's account of the gall-bee, and the death-watch, in vol. 20. "A Letter concerning an Insect commonly called the Death-watch," vol. 22. which respects both ptinus pulsator, and hemerobius pulsatorius, written by William Durham; and also a supplement to an account of pediculus pulsatorius or death-watch, in vol. 24.

But, in point of priority, we ought previously to have mentioned the earlier works of Leeuwenhoek; a writer whose astonishing assiduity, aided by means of powerful microscopes, has contributed more than any other man, except Swammerdam, to disclose to our view the wonders of the invisible creation, in the sphere of which the minima of the insect race become of the first consideration. One of the first papers of this intelligent observer appears in the eighth volume of the Philosophical Transactions, and is entitled "A Specimen of some Observations made by a Microscope contrived by M. Leeuwenhoek." His communications to the world after this became numerous; and, as the object of his pursuit was of a nature to stimulate a spirit of investigation, it could scarcely at the same time fail to excite controversy. It led, therefore, to the production of many papers by different writers, all which tended, in some degree, to the further elucidation of the subject. As these, however, are only in part connected with entomology, it would be fruitless for us to follow, through the varied branches of discussion, and to select those particular passages which relate to our present inquiry; for these we refer the curious reader to Transactions of the Royal Society, from the eighth to the thirty-second volume; and to various publications printed at Leyden and Delft in 1686, 1693, 1697, 1704, &c. Among the principal works of Leeuwenhoek, are "Anatomia, seu interiora rerum, cum animatarum tum inanimatarum (sic) ope et beneficio exquisitissimorum microscopiorum detecta," 1687; "Arcana naturæ detecta," 1695; and "Opera omnia," 1722; an English edition of the select works of this author was undertaken in London in 1798.

Geyerus, in 1687, was author of a medical tract in quarto printed at Leipzig and Frankfort, called "Tractatus physico-medicus de cantharidibus," and which, as the title implies, relates to the medicinal properties of those well known insects, the cantharides. Bononius, in the same year, published a letter at Florence, in which he enters on an extensive detail of his observations on many insects, with the microscope, and lays claim to several discoveries. And J. F. Griendel, Von Aeh, canon of the order of the Holy Ghost, produced his "Micrographia nova" at Nuremberg

also at this time; a quarto volume of sixty-four pages, some of which are dedicated to his microscopical observations on insects.

The work of Stephen Blankaart of Amsterdam made its appearance in 1688. Its author, a Dutch physician, was an assiduous collector, and in this instance produced a work, the plates of which have been as much admired for the beauty of their execution as the work in other respects has been condemned. Frisch, and after him Lyonet, consider it as an indifferent production. It relates chiefly to the larva of different insects, as the caterpillars of seventeen lepidopterous insects, twelve maggots of flies, and a few other insects, amounting altogether to forty-seven subjects. The title is, "Schou Berg der Rupsen, Wormer, Maden en vliegende Dierkens daar uit voort-kommende." The paper of John de Muralto, and also that of C. Mentzelius, relating to different insects, appeared about this period; and the work of John Cyprien, "Historiæ Animalium," was also printed in 1688; it was published at Frankfort, and relates to insects among other animals. A small tract, an oratory paper of eight pages, with a single plate, entitled "Chymica Formicarum," is from the pen of professor Sperling in 1689. Koenig's "Regnum Animale," &c. printed in 1690; Bilberg's "Locustæ," a dissertation, printed at Upsal in 1690; and "Historia Vermium" by Jungius, printed at Hamburg in 1691, are all interesting, and a paper by Sedileau, published in 1692 in the Memoirs of the French Academy, is rather curious; this latter is denominated "Observations sur l'origine d'un espece de Papillon," and the insect treated upon is bombyx pavonia γ major. The prodigious ravages occasioned by the swarms of locusts which, in the month of August 1693, over-ran Germany, and extended their scattered legions throughout the rest of Europe, even to the borders of the most northern countries, were an event of such an afflicting nature, that it could not fail to engage the observations of many writers, in the number of which we meet with the names of some naturalists of ability, whose dissertations on this occasion are acceptable. Treunero, Hebenstreit, Woollenhaupt, Crellius, Kirkmajor, and Ludolfus, wrote at this time on the subject, relating the particulars of their appearance, the devastations committed, and the most effectual means of destroying them. The species was the common migratory kind, gryllus migratorius. These tracts were generally trifling in point of size, that of Hebenstreit, however, "De Locustis immenso agmine aërum nostrum impletibus, et quid portendere pütentur," consists of 65 pages and one plate, and that of Ludolphus, entitled "Dissertatio de Locustis, anno præterito immensa copia in Germania visis, cum diatriba, qua sententia autoris de  defenditur," is a folio of eighty-eight pages, and embellished with figures.

Albino published a small tract on the cantharides in 1694, and the following year "Jacobi Petiveri Musæum," a small octavo, was published in London. These, with the elementary work of Jacobæus, "Dissertatio de vermibus et insectis," and that of Baglivus, printed at Rome in 1696, on the effects of the bite of the tarantula, and a paper of Homberg on the libellula virgo in the Memoirs of the French Academy for 1699, appear to be the only publications deserving of mention till the commencement of the eighteenth century.

The earlier part of the eighteenth century forms an era in which the science of entomology was cultivated with the happiest success. It is with some pride also, we observe, that even in the comparatively improved state to which the science had then attained, it derived no incon-

siderable advancement through the labours of our own countrymen. The works of Ray and Lister, with those of Petiver in England, and those of the indefatigable Reaumur in France, contributed essentially to this purpose, and to the present day serve in some measure to maintain the reputation of science. The works of those authors were succeeded within the first fifty or sixty years by other works of high consideration, as will be found hereafter. In the interval of time that elapsed between the publications of those more extensive and valuable works, others of less importance, but which yet deserve mention, made their appearance; as, for instance, in 1701 the small, but curious dissertation of Heucherus, called "*Araneum homini perniciosum et salutarem*;" the little treatise by Vallerio of Upsal on the tarantula, published the year after; the entomological part of the work of G. B. Rumphius, in 1705, and that of Ruifsch, "*Theatrum universale omnium animalium*," published in 1710—1718. Henninger produced a small medical tract relating to millepedes, in 1711. Wedelio on an old subject, the utility of the cantharides, in the *Materia Medica*, at Jena, in 1717; and Whitaker, the year following, on the same insect: the remarks of J. Pontedera, "*De Cicada*," &c. annexed to his botanical work; and two tracts by Laurentius Roberg, medical professor at Upsal, "*Formicarum Natura*," and "*Libella infesta*."

It was in the year 1702 that Petiver produced the first decade of his "*Gazophylacium naturæ et artis*," the publication of which was carried on progressively till for about ten years after, during which period the work was extended to ten decades, each containing plates exclusive of the "classical and topical catalogues." This work relates to insects among other animals, plants, and fossils. About twelve months before the author's death, which happened in 1718, there was, however, another work printed by him under the title of "*Papilionum Britannicæ Icones*," &c. and which, as the title expresses, relates to the English butterflies, and is entirely confined to entomology.

A work by Ray, appropriated to this branch of science, was published in 1705, under the title of "*Methodus Insectorum, seu in methodum aliqualem digesta*," and which can be considered only as the introduction or prelude to the great work, "*Historia Insectorum*," which the world received in 1710, through the care of Dr. Derham; for Ray did not live to see it published.

This celebrated naturalist divides all insects into two principal classes, those which undergo transformation in their form, and such as do not pass through any transformation after being produced in the first instance. Each of the two principal classes are sub-divided into several orders, which are variously characterized, as by the number of the feet, or by being destitute of those limbs. Some are determined by the habitation of the insects; by the size, or conformation of various parts of the body; by the odour they emit; the form of the caterpillars, and various other peculiarities. This arrangement is in part conformable with the writer preceding; the *intransmutabilia*, or order of those which do not pass through any metamorphoses, is due to Willughby; and the three orders of changeable insects correspond with the 12th, 13th, and 14th orders of Swammerdam's classification. His class of changeable insects is divided into several families, as *vaginipennes*, from having the wings covered with a sheath, *papiliones*, *quadripennes*, *bipennes*, &c. There is an appendix to this work by Lister, "*Appendix de Scarabæis Britannicis*," &c. Ray, like many other writers, includes certain tribes of the *vermes* with insects, from which they are separated by Linnæus; it is possible that Ray might conceive what has been since proved by in-

dubitable authority, that some few, at least, of the supposed *vermes* are no other than the larvæ of insects.

The work of Albin, for the time in which it was executed, was considered as an elegant publication; it is in one volume quarto, containing one hundred copper plates, with a brief description of the objects represented in each, and was originally sold at four guineas a copy, a great price in those times, being published in the year 1720. If we mistake not, another edition is dated a few years later; there is certainly one printed with notes and observations by Dr. Derham, in 1749. Albin was author of a work on English spiders, in which the lice of several animals and birds are represented from the plates of Redi.

At the same time that Albin was engaged in the preparation of the above-mentioned work in England, J. L. Frisch, rector of the Royal Academy at Berlin, was occupied on his history of the insects of Germany, "*Beschreibung von Insecten in Deuschland*," the first part of which appeared in 1720; the whole work consists of thirteen parts, and each part is embellished with three plates. Copies of this work have been printed since that time; the latest we have seen bears date 1766.

Valisnieri, in his work, entitled "*Esperienze et Osservazioni intorno agli insetti*," published in 1730, distributes all insects into four classes, according to the different places in which they are found. The first comprehends those insects which live on plants; the second, such as live in water and other fluids; the third, those that live in the earth, or among stony substances; and the fourth, those which subsist on the other animals, or in their bodies.

Reaumur produced the first volume of his "*Memoirs pour servir à l'Histoire des Insectes*," at Paris, in the year 1734. The five succeeding volumes appeared between that time and 1742. This voluminous work contains some thousand pages, and nearly two hundred plates; and is one of the best productions on the subject that has been submitted to the world. There are two editions of this work, one published in Paris by its author, in quarto size; the other is in octavo, a pirated concern by the Dutch booksellers.

After the works of Ray, Lister, and Petiver, the intelligent entomologists of our own country, in the commencement of this century, the name of Bradley ought perhaps to have been introduced. His publication, "*A Philosophical Account of the Works of Nature*," which was printed in London so early as the year 1721, contains a brief account of insects. This author, though a professor of botany in one of the universities, seems not to have been possessed of any very extensive or accurate information on this subject of entomology; his work at least abounds in the marvellous, but was, perhaps, for this very reason, more likely in his time to have been perused with pleasure by the common reader. As a popular work, it was not in other respects without its advantages. The works of Reaumur in France contributed materially to facilitate the study of entomology on the continent. And about the same time that he was engaged in this field of enquiry, several tracts and papers made their appearance from other individuals. In the memoirs of the French Academy for 1731, there is one entitled "*Expériences sur les Scorpions*," by Maupertuis; and in 1734, some others by Trew, as "*Insectorum quodam genere*," "*De duabus Ericis*," and "*Peculiare quoddam Quercus exerescentiarum generis*," all which are inserted in the "*Commerc. Literar.*" of Nuremberg. These papers immediately preceded the publication of the first entomological work which the celebrated Linnæus produced to the world.

The principal writings of Linnæus on this branch of natural

tural science are to be found in his deservedly esteemed production the "Systema Naturæ, five regna tria naturæ systematice disposita per classes, ordines, genera, et species;" the first edition of which is in folio, and was published in 1735. Linnæus in this work distributes insects into four orders, according to the number and form or nature of their wings, under the several names of coleoptera, angioptera, hemiptera, and aptera. The first order contains those insects which have covered wings; the second those with naked wings, as butter-flies, dragon-flies, ephemera, &c. In the third, he enumerates crickets, locusts, bugs, &c.; and in the fourth, those which have limbs, but no wings, as the spider, lobster, &c. Besides these four orders, this primary arrangement of insects comprehends three other orders of animals, referred since to the vermes class, but which, at the period of the first publication of the "Systema," Linnæus considered to be genuine insects. The first of these includes all creeping "insects" whose body is naked and destitute of limbs, as the earth-worm and the leech: the second, both land and sea-shell animals; and the third, those furnished with limbs, as the echinus, asterias, &c.

Linnæus by no means deviated from the received opinion of his time, in placing the first and third of these last mentioned tribes of animals with insects. These bodies were considered as appertaining to the insect race by most of his immediate predecessors, and by some naturalists in earlier times. In a subsequent edition of the Linnæan work, these orders are separated, and the latter constituted into a distinct class after the manner of Aristotle, who points out the natural obvious difference which prevails between these two orders of animals with so much clearness, that we are not without some surprize his example was overlooked by Linnæus in the first instance. Linnæus, according to this plan, in his later works, separates the echini, &c. under the denomination of vermes. The insects alone were then extended by him from four to seven orders. This is the arrangement which his class "Insecta" finally assumed in the edition of 1767, and which is still adopted by the admirers of Linnæus. The following are the definitions of the several orders established by this eminent naturalist.

*Coleoptera*, such as have crustaceous elytra, or shells, which shut together, and form a longitudinal suture down the back of the insect, as in the chafer-beetle. In most insects of this class, the elytra cover the abdomen entirely, in others but partially, as in the ear-wig, &c. The word is derived from *κολοῦς*, a sheath, and *πτερόν*, a wing.

*Hemiptera*, which have their upper wings most commonly half crustaceous, and half membranaceous, not divided by a longitudinal suture, but incumbent on each other; as in the water scorpion and grasshopper. From *ἡμισυ*, half, and *πτερόν*, a wing.

*Lepidoptera*, having four wings covered with fine scales in the form of powder or meal; as in the butterfly and moth, from *λεπίς*, a scale, and *πτερόν*, a wing.

*Neuroptera*. In this order the wings are membranaceous, transparent, and naked, and are generally reticulated with veins or nerves; the tail is without a sting, as in the libellula or dragon-fly. The term is derived from *νεῦρον*, a nerve, and *πτερόν*, a wing.

*Hymenoptera*, have four membranaceous wings, and the tail furnished with a sting for various purposes, as in the wasp, ichneumon, &c. From *μῆνι*, a membrane, or pellicle, and *πτερόν*, a wing.

*Diptera*, with two wings only, and poisers as in the house-fly; from *δύο*, two, and *πτερόν*, a wing.

*Aptera*, have no wings; as the spider, &c. from *ἀ*, without, and *πτερόν*, a wing.

The great perspicuity of the Linnæan system of entomology arose from its author having made choice of the most obvious characters which insects afford for the leading distinctions of his orders, such for instance as the number, texture, and position or folds of the wings, or the absence of these parts; and in the construction of the genera, the like attention being devoted to the form of the head, thorax, and wings; and in particular to the structure of the antennæ: these latter being conspicuous in most insects, and so infinitely varied in their appearance as to constitute in general a permanent definition. That there are other characters which, in the opinion of later entomologists, are better adapted to the purpose of classification the reader must be aware, but these, although really preferable in some respects, are perhaps too minute to become always useful. The structure of the various parts of the mouth, the character on which the Fabrician system is founded, however definitive, and therefore excellent, requires that degree of attentive scrutiny in their examination, which is rarely bestowed by the ordinary observer of nature; and which cannot for this reason be so well calculated for the general purpose of discriminating the families of insects, as those which are at once too obvious to be mistaken.

The simplicity of the arrangement adopted by Linnæus, the celebrity of his name, and the princely patronage under which he wrote, conspired with other favourable circumstances to render this science more universally cultivated, admired, and respected about his time, than it had probably been at any former period. The credit due to this naturalist for his labours in entomology is great. This we allow, but, let us also remember, that he is not alone entitled to our commendation for the arrangement proposed in his work. We must in candour acknowledge the merits of many among his predecessors, who wrote under circumstances of less encouragement, and have nevertheless excelled in this science: men to whom the writings of Linnæus stand in a very high degree indebted, and without the aid of which it is impossible to imagine the system, which now commands our admiration, could have been produced, at least in its present state of purity.

From the various entomological works extant before the time of Linnæus, it may be collected that the history of these creatures was deeply investigated prior to the appearance of his writings; and even that system itself, the prominent feature of his labours, from progressive advancement, had gradually attained to a state of considerable perfection. In the works of Aristotle and Pliny, in those of Agricola, Aldrovandus, Frenzius, Mouset, Swammerdam, Ray, Willughby, Lister, Vallisneri, and various others whose names have been already repeated, we distinctly perceive, with some occasional variation, the outline of the superstructure raised in the "Systema Naturæ."

These valuable sources of information furnished him with abundant materials, from which he selected with profound judgment, and interwove with ability, industry, and success. Linnæus was in this respect commendable; he did not suffer his mind to be swerved on this occasion from any ambitious or innovating motives; and so far as he deemed it consistent with his plan, he appears to have adhered to the examples of his predecessors. The characters of his ordines are to be found in several earlier publications than his own, and so likewise are most of his genera, and the far greater number of his species. But these he remoulded throughout with so much skill, that this "Systema" constitutes the central point in which the scattered rays of natural science are concentrated with more precision than they really appear in the original authors, to whose industry he stands indebted. It

was in the concise and very expressive style which Linnæus adopts in all his works, and which was almost peculiar to himself, that he excelled.

Our limits are inadequate to the fair discussion of this important subject; and of this we feel so deeply sensible, that for the present we shall waive all further comment, reserving to ourselves a future opportunity for entering upon a more extensive view of the merits of the Linnæan system, as contrasted with those of other authors who have appeared since his time, and which have obtained the sanction of public approval.

After the first edition of the "Systema Naturæ," Linnæus wrote several papers on the subject of entomology; some of which are printed in the Transactions of the Royal Society of Upsal. One of the earliest of these appeared in 1739, under the title of "Om Renarus Brömskolor i Lapland;" and another dated Stockholm, in the same year, "Tal om Märkwadighter uti Insecterne." In 1746, we find a paper, jointly the production of Linnæus and Degeer, relative to the lantern-fly of China (*fulgora candelaria*); and about the same time, his "Fauna Suecica," an enlarged and improved edition of which was published in 1761. That elegant insect, *panorpa coa*, a scarce species at that period, forms the subject of a small Linnæan paper in 1747. His dissertations "Miracula Insectorum," and "Noxa Insectorum," bear the same date, 1752: they were both printed at Upsal, and possess merit: the latter is in particular valuable, from the object in the contemplation of the writer. Six years after this he produced a dissertation, called "Pandora Insectorum;" the year after, a paper on the coccus; and in 1761, his "Fundamenta Entomologiæ," a book in those days of considerable value as an elementary work, or introduction to this study. There is a translation of the tract by W. Curtis, printed at London in 1772. His last entomological paper is upon the genus *pausus*, a curious coleopterous tribe, distinguished by the comparatively enormous magnitude of the antennæ.

The work of L'Admiral, entitled "Naawkeurige Waarneemingen van Gestaltverwiffelende gekorwene Diertjes," appeared in 1740 at Amsterdam. It is in folio, and contains a series of elaborately finished etchings, which, though engraven in a dissimilar style, have somewhat the air of Merian's work on the insects of Surinam, or as is distinctly copied in the Aurelian of Moses Harris. The work of L'Admiral is confined to the European insects, of which it comprehends about fifty species of the larger kinds, and those principally of the lepidopterous tribe. These are represented in a heavy, though not unpleasing, and often very beautiful manner, in various attitudes, with large branches of the different kinds of plants on which they feed; and in most instances, the perfect insect is accompanied on the same plate with the larva and pupa. L'Admiral's work began in numbers, and was intended to contain, according to its author, one hundred plates and four hundred pages of letter-press. This design was never completed. There are few copies with more than twenty-five plates, and about five pages of letter-press. Our copy contains thirty-two plates and twenty pages, and is the most complete in this respect we have seen.

A small treatise relative to the larvæ of phalænæ, by Detharding, "Disquisition Physica Vermium in Norvegia, qui novi vili," was published in quarto in 1742. The same year, the tarantula spider engaged the attention of Francesco Serao of Naples, who on this subject only has given a quarto of two hundred and sixty pages, entitled, "Della Tarantola o vero Falargio di Puglia." The history of the tarantula about this time engaged the pen of several curious

persons; and, among others, N. Caputus had the year preceding published a book nearly the same size, "De Tarantula: Anatomie et Morfu."

The work of Lesser, "Insecto-theologia," &c. written in the German language, and better known from the French translation by Lyonet in 1742, entitled "Theologie des Insectes," is rather a curious than valuable publication. The success of this book in Germany renders it worthy of particular mention. The views of its author, (a clergyman at Nördhausen,) as he himself explains, was to "promote the glory of God." He does not aspire to the establishment of any new facts relative to entomology: his attention is directed solely to the selection of such anecdotes and particulars of the history of insects, gleaned from other works, as could be rendered a convenient medium for the theological remarks with which his pages abound. The piety of his mind we shall not distrust: to an entomologist his work is of no material worth; he was not very well acquainted with this subject, and his remarks are often erroneous. As a theological production, and in this view the author wished it to be considered, certain passages in the work of Lesser may have an useful tendency: it is calculated to expose some glaring errors in the writings of other theologians, who in a spirit of fanaticism had entered upon the same subject. One of his best chapters on this head is that relating to the "abuse of insects in theology;" in which he points out the gross outrage on reason committed by the pagans, in making certain insects the idols of their worship; and remarks how much more absurd it must appear, that the Jews and even Christians should have followed their example: a fact inferred by him from various authorities. The Jews are accused of stating many wonderful things relative to insects, which can only be considered as fables. Among others, after repeating the sacred text, 1 Kings, vi. 7. concerning the erection of the temple, which was "built of stone made ready before it was brought thither; so that neither hammer, nor ax, nor any tool of iron was heard in the house, while it was building," he states, that the Jews explain this passage in the following manner. The workmen, they affirm, employed a worm to shape the stones; which insect, named schamir, cut and broke them to pieces in places where applied. They add, that it was the figure of a grain of barley, and was kept in a leaden box, because, had it reached any rocks, it would have cleft and destroyed them. This fable, with some others invented by the rabbis, is particularly mentioned. Among the legends of Catholic superstition he selects other anecdotes equally remarkable. Baldus, he says, in order to prove the real presence in the eucharist, relates that a number of bees being found on holy ground, paid it homage, and carried a portion of it respectfully to their hive. Baptiste tells us, that a spider having accidentally fallen into the chalice, while St. Francis was saying mass, the holy man determined to swallow it; and adds, that the spider came afterwards out of the bone of his leg. But to conclude with one of these tales of fanaticism not unworthy of record with the rest: it is gravely stated that St. Francis, once walking in a garden, saw a grasshopper, which immediately quitted the plant it sat upon, and perched on his hand; he ordered it to sing to the praises of God, and with a pretty loud voice it immediately began a very fine psalm! If such holy impollures were actually listened to with any faith, the time of Lesser could not be misapplied, as a divine, in endeavouring to expose their absurdity.

Degeer published at Stockholm, in the year 1744, an interesting little octavo on the utility of the study of insects, called "Tal om nyttan, som Insecterne och deras Skärskådande,

dande, tilskynda öfs;" in which he points out the advantages likely to result from our acquaintance with this tribe of animals, and which appears to be the first tract expressly written under this view of entomology. About this same period, Röfel of Nuremberg, by profession a miniature painter, was engaged in the preparation of a valuable entomological work, the first part of which was shortly after produced to the world. This work bears the title "Der Monatlich-herausgegebenen Insecten-Belustigung," and consists of several volumes in quarto. The first part was produced in 1746, and two succeeding volumes in 1749 and 1755; to these a fourth volume was added by his relation Kleemann, 1761, two years after the death of Röfel; and since that period Kleemann has published three other parts in continuation.

Röfel does not adopt any scientific order of arrangement: his work was produced as a miscellany, and, according to the title, as an amusement in the study of insects. Many of the insects included are European; others are natives of Asia, America, &c. Besides insects, some few of the crustacea are contained; and a portion of the third volume is devoted to the vermes tribe. The text is in the German language, and exceedingly copious; the slightest peculiarity in every individual insect being descanted upon with as much minuteness as the more important details of its history. The plates are numerous and interesting. The supplemental fasciculi given by Kleemann, "Beyträge zur Natur-und Insecten-Geschichte," &c. relate to European insects, and a small number of the extra European kinds.

A tract, dedicated to the purpose of explaining the advantages arising from the study of insects, was printed in 1747, by C. F. Mennander, "Dissertatio de Usu Cognitionis Insectorum." Bazin, the same year, published his "Abregé de l'Histoire des Insectes, pour servir de suite à l'Histoire naturelle des Abeilles," in Paris; and in London, William Gould, "An Account of English Ants." T. C. Hoppe published, the year after, two small entomological tracts, as "Antwort-Schreiben auf Hrn Schreibers zweifel," at Gera; and "Eichen-Weiden-und Dornrosen," at Leipzig; and J. Dufield of London, six numbers of a natural history of English moths and butterflies, after which the work discontinued.

About this same period, or rather earlier, but certainly before the year 1749, a work was undertaken in London by Benjamin Wilks, under the title of "The English Moths and Butterflies, together with the Plants, Flowers, and Fruits whereon they feed, and are usually found." This publication, consisting originally of plates only, appeared in the first instance without a date. From collateral circumstances we are, however, enabled to state that it must have preceded the year last mentioned; because at that time the whole work, consisting of 120 plates, was nearly completed, as we learn from comments upon that work in the third volume of Röfel's *Insecten Belustigung*. The nature of this work is rather incorrectly stated in its title page; for the plants on which the groups of insects are respectively displayed are not those which constitute their natural food: they consist of gaudy flowers, auriculas, roses, monstrous varieties of cultured plants, fruits, &c. the introduction of which, in preference to their natural food, has incurred blame. But another charge, and one in our opinion of more importance, is brought against our author by Röfel; an imputation tending to depreciate the respectability of the English entomologists of that particular crisis, when the science ought, from the labours of former writers, to have stood in this country on very high ground, and the public judgment to have been so far matured as to

discover imposition. He plainly accuses our author of piracy; and when we reflect on the celebrity this work has heretofore enjoyed as an original production, it does attach some little reproach at least that facts stated with the utmost publicity on the continent should have remained unknown to us. The remarks are curious; and as in all probability they have not before met the eye of the English reader, we shall translate the passage in this place: "In dem nachtragoder 3," &c. "In the supplement, or third part of my Amusements of Insects, I have mentioned a certain work which Mr. Wilks in London publishes monthly, and promised that I would be more circumstantial at another time. Since then the plates amount to ninety, all which I have examined with great attention: they are as yet destitute of any description, which, however, is to appear at some future period. If the notice which accompanies these plates deserves credit, all those insects are drawn after life; but to those who know other works, and examine these plates with caution, it soon appears that the author has copied several from Albin's insects, from Merian's book, and a great many from my own. Whether he has been successful in his attempt, I leave to the judgment of others. An ape mimicks every thing, but does not always succeed. This may appear to many to be too severe; but let them consider that the author counterfeits the works of others, and gives them out as his own. I venture to assert that in the future description of his work, he will take care not to tell us from what books he has compiled his own; for he already strives to hide on his plates whatever he has copied from others, by reversing the figures, or by giving them a different position." Vol. iii. p. 192, A.D. 1749. This we must consider as in some measure the language of repentment for the liberties taken with his work: it is nevertheless in substance true; for the eye of the artist will perceive, on comparing the two publications, that Wilks has taken an unlimited range through the first volume of Röfel. The remarks are repeated at length, because we wish to impress on the public mind the value and importance of any genuine work, in preference to productions of this nature. Wilks was the publisher of "Twelve new Designs of Butterflies," in which the insects are disposed in stars, festoons, circles, or other whimsical groups, forming what are usually denominated "Butterfly pictures."

The first volume of the invaluable work of baron Charles de Geer, the "Memoirs pour servir à l'Histoire des Insectes," was printed at Stockholm in 1752, and was received with every demonstration of praise, to which its merits are entitled. From the testimony of the author's talents which this volume afforded, the continuation was expected with impatience; but nine years elapsed before the second volume appeared, and it was altogether twenty-six years from its commencement to its termination. It was completed in 1778, in which year the labours of its author closed with his life. De Geer was the author of many other publications, which are to be found dispersed through the Transactions of various learned societies; but that above noticed is the most considerable of his works.

Dr. Hill, in his history of animals, published in London in the year 1752, divides insects into three classes: the first of which, apteria, comprehends all insects without wings; the second, pteraria, is devoted to the winged kinds; and the third, called gymnarthridia, consists of those which have soft and naked bodies, and are furnished with limbs. The apteria is divided into two families; and pteraria, or the winged insects, into diptera and tetraptera, or those with two wings and four wings.

The "Entomologia Carniolica" of Scopoli appeared in

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1753. This author distributes all the insects of which he treats into orders, genera, species, and varieties, nearly after the manner of Linnæus; changing, nevertheless, the names they bear in the works of the latter for others he deemed more appropriate. Thus, for example, proboscidea is substituted for hemiptera, in reference to the beak by which these insects are distinguished; aculeata for hymenoptera, from the abdominal sting; halterata for diptera; and pedicellaria for aptera.

As a systematic work, this publication of Scopoli is of small importance; in other respects it is valuable. The arrangement of insects, better known on the continent as the system of Scopoli, appeared in a work, entitled "Introductio ad Historiam naturalem," printed so lately as the year 1777, and which, as the title expresses, does not relate exclusively to the science of entomology. He divides insects into five tribes, under the singular appellations of Swammerdamii-lucifuga, Geoffroy-gymnoptera, Roessli-lepidoptera, Reaumurii-proboscidea, and Frischii-coleoptera: by this means, identifying each particular tribe with the name of an author, who in his opinion had been most successful in the explanation of that to which his name is attached.

The order lucifuga includes two genera, crustacea and pedicularia; gymnoptera comprehends halterata, aculeata, and caudata; lepidoptera, the genera sphinx, phalæna, and papilio; proboscidea are divided into two parts, the terrestrial and aquatic; and the coleoptera, in the same manner, consist of two families, the inhabitants of the water and those of the land.

The ardour with which the science of entomology was cultivated about this period in various parts of Europe, is to be ascribed to the occasional labours of Linnæus and his immediate coadjutors, whose example excited the most laudable assiduity; and though no work of any material consequence appeared exactly at this time, we may safely conclude that this spirit of emulation laid the foundation of several which were submitted to the world a few years after. Among the entomological tracts and papers of this time, some only are worthy of notice. Kalm, a name familiar to the botanist, bestowed attention on this subject, as we perceive from a paper on a species of cicada, (septemdecim,) written in the Swedish language; and also from another by the same author on acarus americanus: these appeared in 1754. The year after G. W. Sigwart treats slightly on coleopterous insects; and Sauvages produced some papers of little moment in the Memoirs of the French Academy. And now we proceed gradually to the consideration of other works of greater consequence; the useful work of Clerk on the spiders of Sweden, printed in 4to. at Stockholm, in 1757, is one of the best works extant on this curious tribe. Another production by the same author is also valuable, his "Icones insectorum rariorum," a thin and small quarto, published two years after. Indeed, this last mentioned work may be considered as having the immediate sanction of Linnæus, from being produced under his own direction, and, we believe, inspection. The work contains a moderate number of coloured plates, some of which are appropriated to the display of select exotic insects of the moth and butterfly tribe, and others to the more choice and rare lepidopterous insects of Europe, all which are highly finished in colours. There were only a few copies of this work printed off, and it is now become scarce, and bears a considerable price. Dr. Smith possesses one copy, that originally in the library of Linnæus, and there is another in that of sir Joseph Banks.

An interesting little work, called "Insecta Musei Græ-

cenfis," from the pen of Nicolaus Poda, published in 1761, affords an account of the insects of Greece, arranged in the Linnæan manner. The same year an introductory work to the study of insects by J. H. Sulzer, was printed at Zurich; it is in quarto, with a number of plates, and bears the title of "Die Kennzeichen der Insekten durch 24 kupfer-tafeln erläutert, und mit derselben natürlichen geschichte begleitet." The same writer, in 1776, produced another publication also introductory to the science of insects, called "Abgekürzte geschichte der Insekten," illustrated with thirty-two coloured plates; which latter, with five or six additional plates, form the historical part of the quarto work published in Switzerland, in 1789, by J. J. Roemer, as an elucidation of the Linnæan and Fabrician systems. The title of the latter is "Genera Insectorum Linnæi et Fabricii iconibus illustrata." The outline of the Fabrician system, which this work contains, is conformable with that proposed in the earliest work of the last mentioned entomologist.

As a systematic production, the work of Geoffroy, printed at Paris in 1762, demands the particular attention of the modern entomologist. The work is entitled "Histoire abrégée des Insectes," and comprises all the insect tribes in the six following classes: 1st, coleopteres; 2d, hemipteres; 3d, tetrapteres à ailes farineuses; 4th, tetrapteres à ailes nues; 5th, dipteres; 6th, apteres. The first class corresponds with the Linnæan coleoptera; the second is more accurately regulated by the form of the proboscis; the third agrees with the lepidoptera, having the wings covered with fine powder; the naked-wing tribe unite the neuroptera and hymenoptera; the dipteres and apteres are the same with the Linnæan orders. It is a material distinction of this system, that the characters of the orders are determined chiefly by the number of joints in the feet; the general characters are taken from various parts of the body, wings, &c. The genera differ exceedingly in their construction from those of Linnæus, and many of them are in use to this day among the continental writers.

Brünniche is the author of two entomological tracts, printed about the same period, as, "Prodromus Insectologiae Siælandicæ," and an elementary work in Latin and Danish, called "Entomologia sistens Insectorum tabulas systematicas, cum introductione et iconibus." Sepp began his work, "Beschouwing der wonder gods in de minstgeachte schepzelen of Nederlandische Insecten," in the year 1762; it is dedicated entirely to the more uncommon moths and butterflies of Holland; the text is in the Dutch language, and the plates, which are not numerous, are admired for their peculiar neatness, being engraven in the dot or stipple style, with considerable delicacy.

This elaborate kind of engraving was in great esteem about the period adverted to, as appears from the encomiums bestowed on the plates executed by the hand of Lyonet, for his laborious work, "Traité Anatomique de la Chenille," printed in Holland the same year. This work of Lyonet is a treatise dedicated solely to the anatomy of the caterpillar, which lives in the wood of the willow, (phalæna cossus,) upon the dissection of which this author enters with such minuteness of investigation, that his descriptions of this object alone occupy rather more than six hundred quarto pages. The plates, eighteen in number, with the exception of the first, which represents the microscope employed in his examinations, are entirely appropriated to the representations of the muscles, tendons, fibres, medullary vessels, spiracles, &c. every part of which throughout the whole animal are exhibited in their natural and magnified appearance. These plates, as before intimated, are finished specimens of the stipple style of engraving then prevalent, and which,

which, from the closeness of its texture, nearly resembles mezzotinto.

Lyonet is said to have left at his death two manuscripts on the subject of entomology, neither of which have, to our knowledge, appeared before the world. One of these is inscribed "Œuvres Mêlées sur les Insectes," and contains his observations on the insects found in the environs of the Hague, where he resided. The other, an "Essai Anatomique sur la Chrysalide et la Phalène qui range le bois de saule," a work on the same plan, and forming a continuation of the history of the same insect, as his former essay on the caterpillar. This unpublished work on the chrysalis and fly was to be accompanied by no less than fifty-four plates, all the drawings of which were executed, and some of the plates engraved, previously to the death of the author, which happened, at an advanced age, in 1789.

The science derived some improvement from the various publications of Schæffer between the years 1764 and 1777. He produced, among others, an elementary work in German, "Zweifel und Schwürigkeiten, welche in der Insectenlehre annoch vorwalten," and another, entitled "Elementa Entomologica," containing no less than 132 plates, appropriated to the illustration of the principles of his system; and an additional section with two more plates, describing the various apparatus for catching, and the manner of feeding insects, microscopes for examining them, &c. "Vierter abschnitt von den Werkzeugen der Behandlung und Sammlung der Insecten." The most important of Schæffer's works, is that entitled "Icones Insectorum circa Ratisbonam indigenorum," comprised in three volumes 4to. with a vast number of coloured plates, the latter of which possess a character of great peculiarity in having two impressions on every print, one on the front of the leaf as usual, and the other on the back; by which means the plates are comprised in half the number of leaves they would otherwise occupy. The classification of Schæffer differs extremely from that of Linnæus; it approaches that proposed by Geoffroy, from which, however, it is still so far distinct, that being a system in some repute, it may not be amiss to present an outline of it in this place.

Schæffer divides all insects into seven classes, in the following manner:

1. Insecta coleoptero-macroptera, insects whose elytra are crustaceous throughout their whole length, and extend beyond the abdomen when closed.
2. Insecta coleoptero-microptera, differ from the former only in having the wing-cases shorter than the abdomen.
3. Insecta coleoptero-hymenoptera, or hemiptera, such as have the elytra half crustaceous, or becoming membranaceous towards their extremity.
4. Insecta hymeno-lepidoptera, or having wings imbricated with scales.
5. Insecta hymeno-gymnoptera, or with naked and membranaceous wings, comprehending the two Linnæan orders neuroptera and hymenoptera.
6. Insecta diptera, or insects having two wings.
7. Insecta aptera, or without wings.

The second part of "Zoophylacium Gronovianum," by Laur. Theod. Gronovius, contains the description of about six hundred insects with synonyms after the Linnæan manner, accompanied by four illustrative plates. The work is in folio, and was printed at Leyden in 1764.

Seba, in his splendid folio work, "Thesaurus Naturæ," published at Amsterdam in 1765, describes a number of the larger kinds of extra European insects, with figures executed with great force, and in a style corresponding with the other plates of his work.

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In 1769, Berkenhout published the first edition of his "Outlines of Natural History of Britain;" since which time two other editions of the same work have appeared. That portion of the work which is devoted to entomology includes a small selection of the species most conspicuous for their size, under each of the Linnæan genera, the insects being arranged throughout in the order of that system. The number of insects described amount to about six hundred. The work is destitute of figures.

Among the number of exotic insects figured in the plates of "The History of Birds," and the "Gleanings," by George Edwards, some are interesting from their beauty. There are a few also remarkable for their rarity, particularly scarabæus atlas, one of the three larger "Indian beetles;" libellula chinensis, called "the green-winged libellula;" and the larva or pupa of an extraordinary gibbous kind of locust, represented only, we believe, in this work. Insects were not sparingly introduced, notwithstanding that they were considered only as ornamental objects, the work being devoted principally to ornithology. In the course of the whole of this voluminous production, more than fifty species of the insect tribes are noticed, the greater part of which are butterflies. Edwards began this publication in 1743, from which period it was continued progressively till 1764. The catalogue was published in 1770, and forms part of the tracts entitled "Edwards on Natural History."

John Reinhold Forster, one of the eminent naturalists who accompanied the celebrated Capt. Cook in his voyage round the world, has left us a catalogue of British insects printed in 1770. It is only a list of Latin names of a certain number of species, and was intended as a prelude to the copious work on the insects of this country, which its author intended to write. This catalogue, however, and his "Novæ Insectorum Centuriæ," which appeared in London the year after, are the only entomological works that author published. Of the latter we ought to speak more at large. The avowed purpose of this little book, as the reader is informed in the preface, was to give a description of one hundred insects not mentioned in the latest work of the illustrious Linnæus. The insects included are partly indigenous, some are from China, and others from South America. The greater number of these are coleopterous insects, and are arranged after the manner of Linnæus, though the genera anthribus and cistela are taken from Geoffroy. It may be lastly observed, that although these insects do really appear to be undescribed by Linnæus, some few of them were previously made known to the world by the works of Schæffer and Drury. This its author was aware of, but as they had escaped the observation of the author, whose work he was solicitous to improve, it was still considered right to introduce them.

The first volume of the "Illustrations of Natural History, wherein are exhibited figures of exotic insects," &c. by D. Drury, was published in 1770. The plates, fifty in number, form a miscellaneous assemblage of the more beautiful extra European insects, which the extensive collection of its author afforded. The second volume was produced three years after the first; and the third, which concludes the work, so far as the author proceeded with the publication, appeared in 1782. Besides the insects represented in these volumes, the extensive cabinet of the author contained many very choice specimens, reserved as materials for the fourth volume which was in contemplation; and among the rest, a number of curious species collected in the interior of Africa, and other countries rarely visited by Europeans, the introduction of which would have rendered the fourth volume of much greater interest to the entomologist than

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either of the preceding; this may be collected from the manuscripts of Mr. Drury, in the possession of the writer of this article, and which are now before us. From an inspection of these papers, it likewise appears, that the author intended, in a revival of his former volumes, to have assigned the Fabrician names to all the insects contained, so far as these could be obtained, and that for this purpose Fabricius had himself furnished Mr. Drury with a number of names and references, independently of those which had been published in his "Species Insectorum," a paper by Sebastiani, "Insecta ad aquas Mattiacas super nive deprehensa," bears the same date with Drury's first volume of exotic insects, and as nearly as we can ascertain Kahn was about this very period engaged at Berlin in his publication "Anecdoten zur Insekten-geschichte," a work written in German, and published in numbers. The tract of Kahn, relative to the mode of catching and preserving insects, called "Kurze Anleitung Insekten zu sammeln," is dated 1773.

The "Institutions of Entomology," by Thomas Pattinton Yeats, is the only production of its unfortunate author relative to this subject: it is a translation of the Linnæan orders and genera, collated with three other systems, namely, those of Geoffroy, Schæffer, and Scopoli, together with observations by the translator. This was a valuable book at the time of its production. In the present day it is become rather obsolete; and it is in particular defective in the comparison drawn between the Linnæan system and that of Scopoli; not from any error of the translator, but an event that could not be anticipated. Scopoli coincided nearly with Linnæus in his arrangement of insects, when he wrote his "Entomologia Carniolica;" after which, however, he abandoned that method, and adopted another; that which has since obtained currency on the continent under the name of "Scopoli's System." This last mentioned work was not printed till four years after the translation by Yeats.

"The Aurelian's Pocket Companion," by Moses Harris, is a kind of alphabetical catalogue of the larger butterflies, sphinges, and moths collected in England by its author: a tract of no utility to the naturalist, unless he first condescends to become an adept in the jargon of the aurelian, or, as now termed, the entomological society; the insects being throughout designated by the silly names imposed by the few illiterate persons associated under this denomination. In this English lexicon of entomology, we have "The Wall," "The Bank," "The Turnpike-gate Keeper," "Ghost," "Old Woman," "Dish-clout," and a vast number of others equally capricious and replete with absurdity.

J. C. Fabricius, the indisputable founder of a new system of entomology, published in the year 1775, his "Systema Entomologica," in which the principles of his novel mode of classification is for the first time developed. The essential characters of the classes are determined from the organs of manducation, or mouth (instrumenta cibaria). In this work insects of every description are comprehended in eight classes to which the several names of eleutherata, ulonata, fynestata, agonata, ungonata, glossata, rhingota, and anti-liata, are assigned.

This work obtained for its author very high reputation, and such further inducements to the prosecution of his entomological studies, that in the course of a few years after several other works appeared from his pen on the same subject, among which were his "Species Insectorum," "Entomologia Systematica," &c. in all which his original manner of classification was adopted with progressive improvement. His "Supplementum Entomologiæ Systematicæ," presents an outline of his system in its latest state, and is the basis on which the last work in which he was engaged, his

"Systema Eleutheratorum" was undertaken. Part only of this valuable work has hitherto appeared, its completion being impeded, if not finally interrupted, through the death of the author; but so far as he did proceed, the arrangement proposed in his supplement is adopted, and we cannot entertain any other conclusion than that it would have been acceded to throughout. This may hence be admitted as the best he had formed in the opinion of its author, and a conclusion, the result of so much extensive knowledge in the science as Fabricius possessed, deserves our serious consideration.

In this system Fabricius distributes all insects into thirteen classes, the characters of which are as follow:

Class 1. *Eleutherata*. Jaws bare, free, and bearing feelers.

2. *Ulonata*. Jaws covered by an obtuse mouth-piece

3. *Synistata*. Jaws elbowed near the base, and connected to the lower lip.

4. *Piezata*. Jaws horny, compressed, and usually elongated.

5. *Odonata*. Jaws horny, dentated; palpi two.

6. *Mitofata*. Jaws horny, vaulted; no palpi.

7. *Unogata*. Jaws horny, unguiculated.

8. *Polygnata*. Jaws several (usually two) within the lip.

9. *Kleislagantha*. Jaws several, outside the lip.

10. *Exochnata*. Jaws several, outside the lip, and covered by the palpi.

11. *Glossata*. Mouth composed of a spiral tongue, situated between two palpi.

12. *Rhyngota*. Mouth composed of a beak or articulated sheath.

13. *Antliata*. Mouth composed of a sucker, not articulated.

This able entomologist is the author of various tracts on entomology, written in the Latin and German languages; and also of two principal introductory works, "Genera Insectorum," and "Philosophia Entomologia."

The insects of Switzerland are described by J. C. Fueslin, in an interesting little work, to which its author gives the title "Verzeichnis der ihm bekannten Schweizerischen Insekten," printed at Zurich, and bearing the same date (1775) with the Fabrician "Systema Entomologica."

The number of insects figured in the "New Illustrations of Zoology," by Peter Brown, in 1776, is by no means considerable; some few of which it does contain are nevertheless sufficiently important in point of rarity to deserve explicit mention. The purple-winged locust is, in particular, a magnificent insect: at the time this artist made his drawing, the specimen, which is presumed to be unique, was in the possession of Mr. Tunstal; at present it enriches the splendid collection of Mr. Macleay. The work of Stoll, it should be observed, affords likewise a figure of this species, and which, it is believed, was taken from the same specimen previously to its being purchased in Holland for Mr. Tunstal.

The extensive systematic work of J. A. E. Goeze, called "Entomologische beyträge zu des Ritter Linné zwölften aufgabe des Natur systems," began to be published at Leipzig in 1777, and was continued progressively in parts till 1783. In the same year, with the commencement of this publication, Esper produced in Germany the first part of his useful book on the lepidopterous tribe of insects, "Die Schmetterling in Abbildung nach der natur mit beschreibungen," a work with many plates, and of which a second part was published in 1779. Between that time and 1786 two other parts appeared likewise, and which altogether form

a very extensive publication. Two other very costly works, devoted exclusively to this beautiful order of insects, were also begun in 1779, one at Paris in the French language; the other in Holland, and in the language of that country: the first of these is entirely appropriated to the insects of Europe, and is named "Papillons d'Europe, peints d'après nature;" the latter is by Pieter Cramer, and consists of the extra European species. The title of this work is, "De uitlandsche kapellen, voorkomende in de drie waereld deelen Asia, Africa, en America," and including the continuation published about the year 1782, consists of four volumes quarto, with many plates. The production of these expensive works sufficiently demonstrates the encouragement bestowed on the subject of entomology upon the continent of Europe.

An elementary work by James Barbut, bearing the title of "The Genera Insectorum of Linnæus, exemplified by various specimens of English Insects," was published in London in 1781; and which, besides the text, contains altogether about twenty-two plates, two of which are explanatory, and the rest comprehend indifferent figures of a small number of species in each genera. As an illustration of the Linnæan system, this work may be in some respects useful to the English reader: its views are too limited to admit of more general utility. The author does not seem to be aware of the improvements the science had undergone upon the continent, in the interval between the publication of the "Genera Insectorum" of Linnæus, and the time in which he wrote, and has not therefore drawn those comparisons between them, which, without innovation on either, could not fail to have placed the science in a more lucid point of view. It is, indeed, to the silence of English writers in this respect, generally arising either from the want of information, from sentiments of illiberality, or from negligence, that we must ascribe the very low state of entomological knowledge in Britain, even to the present period. Francisus de Paula Schrank distinguished himself by his enumeration of the insects of Austria in 1781, written in Latin, "Enumeratio Insectorum Aultriæ indigenorum," afterwards rendered into German by Fuefsly. The same year John Nepomuk von Laicharting published at Zurich his catalogue of the insects of the Tyrol, "Verzeichniß und beschreibung der Tyroler Insecten," a second part of which appeared in 1784. Laicharting adopts a system somewhat different from that of Linnæus; he divides insects into ten classes, characterized from various parts of the body. His classes are scarabeides, grylloides, cimicoïdes, papilionoides, libelluloïdes, vespoides, muscoïdes, cancröïdes, aranoïdes, and oniscoïdes. In 1782, a paper by Morand was published in the Transactions of the Paris Academy, entitled "Memoire sur les vers de Truffes, et sur les mouches qui en proviennent." A small octavo by J. S. Semler, in the German language, bears the same date, and is worthy of attention, "Versuch eines Diarium über die Oeconomie mancher Insecten im Winter," and there is besides this another more extensive book printed in 1783, relative to the aphides, called "Nachlese zur Bonnetischen Insektologie." A catalogue of lepidopteræ, written by Lang in the German language, came out in the same year. And, lastly, a "Short history of the brown tail Moth," by W. Curtis. The caterpillars of this moth, it may be recollected by many readers, appeared in such immense swarms in the fields surrounding London during the summer of 1782, and from their ravages despoiled so many trees of their foliage, as to create very serious apprehensions of approaching destruction to the whole vegetable tribe. The object of this pamphlet was to prove that graminiferous plants, not being the natural food of these voracious vermin,

would escape their attack. This circumstance alone will serve to testify, that some benefit at least may result from an acquaintance with the science of insects. Its author was by this means enabled to dispel the uneasiness occasioned through the appearance of these suppoled ministers of famine; and which prevailed to such an alarming extent throughout the whole population of this vast metropolis, that prayers were ordered to be read in all the churches to avert the impending calamity.

An elementary work by J. A. B. Bergstræffer, a small octavo, entitled "Entomologia, scholarum in usus concinnata," was published in 1784; this author had previously distinguished himself by his German work, entitled "Nomenclatur und beschreibung der Insecten in der Grafschaft Hanau-Müntzenberg," &c.

The entomological tracts published about this period, and rather earlier by Thunberg, contributed to promote this science; his dissertations, named "Novæ Insectorum," of which several appeared between 1781, and ten years after; and also his "Dissertatio sistens Insecta Suecica," the first of which occurs in 1784, are interesting. The relation of his travels to the East abounds with information respecting natural history, and relates in some degree to entomology; and he also produced a curious memoir on the pausif genus, called "Beskrifning poa tuänne nya Insecter," besides other tracts in the Swedish and Latin languages.

Retzius, in 1783, produced his "Genera et Species Insectorum," in which the method of Degeer is simplified, and the Linnæan terminology adapted to that performance. Insects, according to this system, are divided into fourteen classes; namely, lepidoptera, alingua, neuroptera, hymenoptera, siphonata, dermaptera, hemiptera, coleoptera, halterata, proboscidea, suctoria, ancenata, atrachelia, and crustacea.

Harrer wrote on the insects of Germany, in a small book printed in 1784. The year after Jabloniky began the important systematical work, called "Natur system aller bekannter in-und ausländischen Insecken," printed at Berlin; about the same time Fourcroy published his catalogue of the insects found in the neighbourhood of Paris in Latin, under the title of "Entomologia Parisiensis;" and another illustration of the elements of entomology, written in German, appeared at Leipzig from the pen of Schmiedlein. Some African insects, that inhabit the Cape of Good Hope, were described in 1786 by Xavier Walfen; and two publications on the lepidopteræ of Germany, and both written in the language of that country, came out in the same year, one by W. Gefenius, the other bearing the title of "Beitrag zur geschichte der Schmetterlinge," and printed at Augsborg, is by Hübnær.

The insects of Naples are described by Dominicus Cyrellus in a folio work published in 1787, called "Entomologie Neapolitanæ." A curious and useful little tract on the oestrus, or gad-fly genus, was the same year printed at Leipzig by J. S. Fischer under the title of "Observationes de Oestroovino atque bovino factæ," to which a copious appendix was annexed in 1788. The cochineal insects discovered at Madras some few years before, gave rise to a series of letters on this important subject, by James Anderson, addressed from Madras to sir Joseph Banks, fourteen of which were printed together in that country in the year 1788; there are, besides these, two other letters which have been published since, also a separate publication by the same author, containing an account of the importation of American cochineal insects into Hindoostan. Swederus, in 1788, published a monograph on that curious coleopterous genus

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terapterus, in a memoir entitled "Beskrifning poa ett nytt genus ibland insecterna, hörande til Coleoptera."

The science of entomology obtained some further advantages about this period, from the publication of the enlarged edition of the Linnæan "Systema Naturæ," by J. F. Gmelin; not from possessing in itself any peculiar merit, but because as a general, and therefore useful work, it combines much valuable information, compiled from the labours of various naturalists of the first consequence since the time of Linnæus. In the entomological part, consisting of three volumes, published at Leiptic in 1788, the editor is considerably indebted to the writings of Fabricius; for although he rejects his mode of classification, his orders, and most of his genera, he has copied no inconsiderable portion of his new species, and by that means very materially augmented and improved the original work of Linnæus. Besides this, the pleasing works of Stoll contributed about this time to facilitate the study of the hemipterous order of insects, from affording figures of many extraordinary species of the locust, fulgora, cicada, cimex, and other tribes, extant in the various continental cabinets at that time, and, among others, that of the prince of Orange. His first work is called "Natuurlykkye af beeldingen en beschryvingen der Cicaden in alle vier waerelds deelen." The two published since are only a continuation, including other genera besides the cicadæ, as the locustæ, phasmæ, &c. These works were printed at Amsterdam. The work of M. B. Borkhausen, written in the German language, relates entirely to European insects of the lepidoptera kind, and bears the title of "Naturgeschichte der Europäischen Schmetterlinge nach Systematischer Ordnung." The first part appeared at Franckfort in 1788; and since that time the work has been considerably extended. The article entomology, inserted in Hall's Encyclopædia, as it appeared originally in 1788, was written by Marsham, and is exemplified by three plates; and about the same time, Roemer published in Switzerland his "Genera Insectorum Linnæi et Fabricii iconibus illustrata," including thirty-seven explanatory plates, nearly all of which, however, had previously constituted the work of Sulzer.

Immediately after this, the publication of one of the most voluminous works on entomology that has been attempted was undertaken at Paris, by G. A. Olivier. Its title is concisely "Entomologie, ou Histoire naturelle des Insectes;" from which we may infer, that its author proposed to have treated on every class and order, and, in conformity with the first part, to have accompanied the whole with figures. Several fasciculi or numbers were published, amounting altogether to about three volumes; the whole of which are confined to the order coleoptera, and that even remains very incomplete. So far as it does proceed, the work is valuable. Olivier is the author of several other entomological writings. In the "Journal d'Histoire Naturelle," he has a memoir, "Sur l'Utilité de l'étude des Insectes, relativement à l'Agriculture et aux Arts." He is also the proposer of a methodical division of insects, in the "Dictionnaire Entomologique." According to this plan, insects are to be divided into four parts, namely, 1. Insects with four wings; 2. Insects with two wings and two wing-cafes; 3. Insects with two wings; 4. Insects without wings in either sex. These are subdivided into eight orders, the characters of which are taken from the mouth.

The insects of Europe were further described by C. de Villers, in a small work published at Lyons, in 1789, under the title of "Linnæi Entomologia," &c.; in which he professes to avail himself of the works of Scopoli, Geoffroy, Degeer, Fabricius, and others. Paykull was at this time

engaged also upon the insects of Sweden, at least on the coleoptera; and this year he published his "Monographia Staphylinorum Suecicæ;" and which, a while after, was succeeded by two other tracts on the curculiones and the carabi, "Monographia Curculionum Suecicæ;" and "Monographia Caraborum Suecicæ." But the most extensive of the works of Paykull is his "Fauna Suecica," in three octavo volumes, printed at Upsal in 1799.

In the "Journal für die Entomologie," the name of Meyer occurs as the author of some remarks on the melonlontha. Preyler, in the year 1790, published at Prague a "Verzeichniß," or catalogue of the insects of Bohemia. Quenfel is the author of a tract on the papilio, entitled, "Beskrifningar öfer 8 nya Svenska Dagsjärillar;" and also of another on noctua pruni, "Beskrifning öfer en y Natfjäril."

The first part of a considerable work, "The Natural History of British Insects by E. Donovan," appeared in the early part of the year 1792; and having obtained a favourable reception, has been continued in a course of monthly numbers from that period to the present time (1800). The design of this undertaking is to afford scientific and general descriptions, accompanied by appropriate coloured figures of every insect discovered in this country; and so far as that desirable object could be accomplished, in all their various states of transformation. In its present form, the work consists of fifteen volumes; the number of plates exceed 500, and these include an extensive variety of species. Without incurring the charge of presumption, the writer of this article believes he may be allowed to observe that the present constitutes the most copious work of its kind that has hitherto, or probably ever may be undertaken, as an elucidation of the entomology of Britain.

The insects of Germany afforded materials for another entomological work of a local nature, commenced by Dr. G. W. F. Panzer, in 1793, under the title of "Fauna Insectorum Initia, oder Deutschlands Insecten;" and this was shortly after succeeded by his "Entomologia Germanica," &c.; both which are written in German and Latin, and are illustrated by plates. Dr. Smith's "Tour on the Continent: in 1786-7," was published also in 1793; and this claims our particular mention, as it will be found to contain some curious observations respecting the insects of the countries he visited. About the same time, a French edition of Fuesly's "Archiv der Insektengeschichte" made its appearance in quarto, with the original plates.

A valuable systematic paper, proposing "a new arrangement of the papilios" by Mr. William Jones, occurs in the second volume of the Transactions of the Linnæan Society, printed at London in 1794. The object of this communication is to point out, that the shape of the wings, which form a principal character with Linnæus in his distribution of this genus into families, though various at the first view, approach each other so gradually, that it is impossible to draw from them the distinguishing line between each family. The number of species known to Linnæus are estimated at rather more than 274, whereas the writer observes he had seen above 1000 in various cabinets, and about 400 more represented in various publications; and from an attentive examination of these is induced to offer the following amendments to the characters of each family, as defined by Linnæus. The latter author describes the *Equites* as having "the upper wings longer from the posterior angle to the point than to the base; and the antennæ often filiform:" this is corrected by saying, "the upper wings are longer from the posterior angle to the point than to the base, occasioned by having four nerves instead of three, visible in

every other family. The palpi frequently only a brush; under wings, with a connecting nerve in the centre, and without an abdominal groove."—*Heliconii*. "Wings narrow, entire, often naked, or deprived of scales; the upper wings long, the inferior short." Linn. To this character is added, that the upper wings have "a connecting nerve in the centre, very slightly grooved to admit the abdomen, which is in general long, as are also the antennæ."—*Danai*. "Wings entire." Linn. Addition: "the under with a connecting nerve in the centre, and a deep abdominal groove; palpi projecting."—*Nymphales*. "Wings denticulated." Linn. Addition: "the under without a connecting nerve in the centre, and with a deep abdominal groove; palpi projected."—*Plebeii*. "Small, rurales; spots on the wings obscure." Linn. Addition: "thorax and abdomen slender; under wings without a connecting nerve; antennæ clubbed;" and these are divided into two sections, those with long, weak, flexible tails; and those without tails, and having the wings entire.—*Plebeii urbicola*. "Spots on the wings for the most part transparent." Linn. These Mr. Jones divides into three families, according to the following character. \* Thorax and abdomen short, thick, or broad; under wings without a connecting nerve; antennæ uncinated, or crooked at the extremity. \*\* With upper wings pointed at the extremity, and long in proportion to their width. \*\*\* Upper wings less extended, and together with their under wings more rotund; their margins entire. There still remain some papiliones, which do not rank with any division above mentioned: these are generally of a large size, without an abdominal groove; have no connecting nerve; their antennæ generally acuminate; and the veins of both upper and under wings extending from their root to the extremity nearly in straight lines. The author of this paper constitutes these as a new family, under the name of romani.

We ought not to dismiss our abstract of the above paper, without observing that, from the great attention bestowed on the papiliones by Mr. Jones, his opinion is of unquestionable authority. The species, which it is intimated the writer has seen in various cabinets to the amount of 1000, or perhaps more, have not to our own knowledge been observed merely: Mr. Jones has taken the trouble, for the gratification of himself and his scientific friends, to paint every species, and that in a very correct and elegant manner. The collection of drawings thus formed affords an unparalleled display of this beautiful tribe of insects.

In 1795, "The Papilios of Great Britain," a quarto work with plates, by William Lewin, was published in London. Whether it was the intention of the author to have proceeded further with this publication is uncertain: it finally terminated with the completion of the butterflies. About the same period the coleopterous insects of Sweden were published in the language of that country, by D. E. Næczén, some part of whose works had, however, been produced to the public before that period. His books (for there are two) are entitled "Befkrifning poa noagra, vid Umeoa fundene okände arter ibland Skalbaggarne," and "Befkrifning poa noagra vid Umeoa fundne Insecter, dels okände, dels foort utydiligen bemarkte och Fauna Suecica ej uptagne." A Latin tract, printed in 1795, by D. H. Hoppe, contains an enumeration of the coleopterous insects found in the environs of Erlang, in Franconia; and in the same year, Latreille published his work, entitled, "Précis du Caractère des Genres." In this last-mentioned work, insects are divided into two principal classes, namely, those with wings, and those without wings. The orders are coleoptères, orthoptères, hémiptères, neuroptères,

lépidoptères, suceurs; thysanoures; parasites; acéphales, entomostracés, crustacés, and myriapodes. An arrangement of the insect tribes, in a manner somewhat different, occurs in "Tableau Methodique des Insectes," by the same author. An important paper on the oestrus genus, by B. Clark, inserted in the third volume of the Linnæan Society Transactions, is duly noticed under the article Bor. The last production we have to mention in the present year is a small tract, accompanied by a coloured figure of an extremely beautiful and singularly formed beetle, in the cabinet of Mr. Francillon; a species of scarabæus, having the posterior legs remarkable both for their length and thickness, and hence denominated the kangaroo beetle (*scarabæus macropus*). The insect is presumed to be a native of Potosi, in South America.

The second volume of "Catalogus Bibliothecæ Historico Naturalis, Josephi Bauks baroneti," &c. by J. Dryander, comprehending the entomological works of that invaluable library, issued from the press in 1796. From the classic manner in which each production is arranged in an appropriate department, according to its leading character, this work must be considered as forming in itself a valuable bibliothecal system of entomological writers. As an assemblage of references, we cannot speak too highly of its contents.

"The Natural History of the rarer Lepidopterous Insects of Georgia," in North America, forms a pleasing accession to our knowledge of those particular species which it is the object of this work to elucidate. The number of insects contained in the two costly volumes, of which the work consists, amounts to about one hundred. These constitute an ample selection of the larger kinds of the butterfly, sphinx, and moth tribes, peculiar to that region. Each insect is represented with its larva, pupa, and an example of one of the plants on which it is known to subsist. This work is written by Dr. J. E. Smith, from a series of notes and drawings made by Mr. Abbot, an assiduous collector in North America; and besides combining the practical information derived from the latter source, is rendered valuable by the numerous additional observations of the author. This work appeared in 1797.

Clairville, the author of a work on the insects of Switzerland, published in 1798, proposes to divide insects into eight orders, somewhat after the manner of Linnæus, but to distinguish them under other names, and to denominate them classes instead of orders. The names he proposes are elyptopteres, dictyoptères, thleoptères, halteroptères, lepidopteres, héminéoptères, rophoptères, and pododunères.

In the same year with the preceding, "Donovan's Natural History of the Insects of China" appeared in London. This is the only work dedicated to the display of the entomological productions of that vast empire that has been published. The materials which constitute the basis of this volume, and from which it was in a great measure composed, were obtained from the first and most authentic sources; including examples of the insects collected at the time of the embassy of lord Macartney, in addition to many others obtained from various cabinets of the highest celebrity, and the communications of friends. The work is embellished with fifty coloured plates. A translation of this publication has appeared on the continent in the French, and another in the German language.

The year 1800 was productive of several valuable works on the subject of entomology; in Sweden, Paykull this year published his "Fauna Suecica," a much-admired publication, in three volumes octavo. Cuvier, with the assistance of

Duméril,

Duméril, brought forward in Paris his celebrated "Anatomie Comparée," a work which, however ill suited to the philosophic taste of our own country, is a production of very extraordinary merit. The organization of the various tribes of insects is treated at great length in the lectures relating to invertebral animals. This work affords us also a new systematical arrangement, in which all insects are divided into two principal sections; those with jaws, and those without jaws. In the first of these orders are comprehended the gnathoptères, neuroptères, hymenoptères, coleoptères, and orthoptères; the second, consisting of such as are destitute of jaws, are, hemiptères, lepidoptères, diptères, and aptères. The fifth volume of "Bibl. Hist. Nat. Banksiana," the addenda of which contains some further mention of entomological writers, was also published in 1800. The last work that appeared in the present year was "Donovan's Insects of India," a publication corresponding in size, and style of embellishment, with the "Insects of China," and, like that work, embracing in a general, though scientific view, a comprehensive display of the more curious, rare, and splendid species peculiar to those fertile regions, the entomology of which it is designed to explain. This work, as in the former instance, is constituted from the first sources of original information. The more immediate intention is the elucidation of the entomological production of the British possessions in India; but it contains also a variety of insects of the more beautiful kinds discovered in the interior of that vast continent, and in the islands situated in the Indian seas.

Lamarck's "Système des Animaux sans Vertèbres," printed at Paris in the 9th year of the revolution (1801), presents a new mode of arrangement for insects. These its author proposes to divide into three primary classes; namely, 1st, those with mandibles and jaws; 2d, those with mandibles and a kind of trunk; 3d, those without mandibles, but having a trunk or sucker. The first of these classes contains the coleoptères, orthoptères, and neuroptères; the second is confined to the single order hymenoptères; and the third includes the lepidoptères, hemiptères, diptères, and aptères. The coleopteræ are sub-divided into three families, according to the number of joints in the feet, as those with five joints in all the feet; those with five joints in each the four anterior feet, and four in those of the posterior pair; and those with only three joints in all the feet. Most of the Linnæan aptera are removed to another class preceding the insect tribe; the only Linnæan genus of aptera, admitted by Lamarck into his order aptères, is the pulex.

The publication of "Marsham's Entomologia Britannica" commenced in the year 1802, with the production of the volume in which the coleopteræ are described. As the outline of the arrangement adopted by this author is strictly Linnæan, those after the manner of that naturalist constitute the first series, and are to be succeeded progressively by the hemiptera, lepidoptera, and other remaining tribes. For the purpose of this continuation very ample materials are provided. Mr. Marsham, whose abilities as an entomologist are well known, has devoted many years of his life to this laudable object: his collection of British insects is of the first class, and his manuscripts of the most valuable kind. The completion of this work must be therefore anticipated as a desirable event. The merit of the first volume is acknowledged, and should the future part appear with corresponding excellence, we could not hesitate in pronouncing it one of the most important works of its kind that has appeared.

Kirby's "Apum Angliæ" was also printed in 1802. This

work contains much curious information relative to the bees of this country; a path of entomology in which its ingenious author has trod with great success. The Linnæan genus apis Mr. Kirby conceives it necessary to divide into two genera, to one of which he retained the original name, the other he terms melitta, and under both genera he describes many species, some of which are noticed for the first time in this interesting work. Latreille, who has written on the Linnæan genus apis, and is esteemed an entomologist of ability, pronounces this "un bon travail." The ninth volume of the Transactions of the Linnæan Society contains an ingenious paper on the apian genus of Herbst by Kirby; and there are also two or three other papers dispersed in those volumes, by the same writer, well deserving of attention.

The contents of the second and third volumes of Turton's translation of the Linnæan "Système Naturæ à Gmelin," relate entirely to entomology. This work deserves further observation. The editor does not, in treating of insects, confine himself to the direct translation of his author; he introduces some commendable improvements in the arrangement after the Fabrician manner; and he besides incorporates from other entomological works of credit, published since the time of Gmelin, whatever prominent traits of information he conceived calculated to amend the original work. We may easily perceive that Dr. Turton has availed himself of the Fabrician "Entomologia Systematica" to a greater extent than Gmelin, and has by this means rendered more essential service to the English reader.

The pages of "Donovan's Tour through South Wales and Monmouthshire," lately published, are interspersed with observations on the various natural productions of the interesting tract of country immediately under consideration. Those digressions, from objects of more general moment, if such the reader be inclined to deem them, we at least may presume to think important; and so far as these relate to the science of entomology in particular, conceive they may, without impropriety, be adverted to in this place.

"Donovan's Insects of New Holland," including also those of New Zealand, New Guinea, and the several islands in the Great Southern and Pacific ocean: this accords with the "Insects of India," already mentioned, being in quarto, with scientific and general descriptions, and in having the similar accompaniments of accurately coloured plates. Of this work it will be alone sufficient to observe, that through the distinguished favour bestowed on the design, the author was allowed to enrich his volume with delineations of those uncommon insects collected during the voyage of captain Cook, by those celebrated naturalists who accompanied that circumnavigator round the world, and which appear for the first time in this work.

The sixth volume of "Shaw's General Zoology" is offered as an illustration of the science of entomology. The work professes only to elucidate the Linnæan genera of insects, with the history of the principal species. This being the intention of its ingenious author, the work is comprized in a very moderate compass. The plates are rather numerous, and in general remarkable for the neatness of engraving. These, however, are not original, being compiled from the plates of Seba, Rosel, Swammerdam, Barbut, and others. The "Naturalist's Miscellany" contains a variety of coloured figures of the more splendid kinds of exotic insects, with descriptions extremely suitable to the general class of readers, for whose purpose they are designed.

Lastly, we ought to mention the work of Coquebert, entitled "Illustratio iconographia," recently published in France: the late entomological tracts of Olivier and La-

treille, the "Faune Parisienne" of Waleknaer, and the papers on different tribes of insects inserted in the Transactions of the Linnæan Society of London; the Société d'Histoire Naturelle of Paris, and those of various other learned institutions, through the medium of which they are distributed to public observation.

Our review of entomological writings is at length drawn to conclusion. In its progress we have endeavoured to include every work of importance in this department of science, that has appeared. To what has been advanced respecting these, nothing material can be added in this place; it was our aim, throughout the present inquiry, to point out the leading character of each work, while passing under immediate consideration, and for this reason we shall abstain from offering any general comments. By connecting the whole in the order of time in which they were produced, our object has been to show at one glance, so far at least as our slight comparisons would permit, those essential respects in which each has materially improved upon his predecessor; and by that means mark the progressive advancement made in the science with some precision. We shall finally dismiss this part of our subject with observing, that it is possible some few works of real worth may have escaped our mention; the number of these, however, we are persuaded, must be very inconsiderable, and confined to such as have recently appeared in countries remote from Britain.

*Classification.*

It will be observed, from the preceding observations, that naturalists entertain very distinct opinions as to the principles on which the classification of insects ought to be founded. This diversity of idea arises from the different views under which they have been considered. Valisneri divides insects into four classes, according to the places in which they live, as plants, in water, in the earth, or upon the bodies of other animals. Agricola into three, namely, those which walk, fly, and swim; Frenzius, into flying insects, aquatic insects, and terrestrial or creeping insects. Swammerdam distributes them into classes from their appearance in the states preceding their final transformation, without particular regard to the last or complete state. In this respect Swammerdam is followed by Ray, whose two primary classes are, of those which undergo transformation, and those which do not; and his orders are determined from their metamorphoses, and the number of their feet. Lister has given a system founded on the figure of the egg in which the insect is inclosed, and the number of the feet. The difference observable in the texture, and also in the number of the wings, form the distinctions of the primary divisions of Linnæus. And lastly, the principal characters upon which insects are distributed, in the arrangement of Fabricius, is taken from the structure of the mouth. Each of the systems founded on those dissimilar characters have gained admirers. The characters of the Linnæan and Fabrician systems appear the best, and are most universally approved.

*General observations on Insects.*

Insects are a race of animals destitute of internal bones, in which respect they accord with a very extensive number of natural families in the lower orders of animated beings. Their bodies are kept in a state of moisture by the circulation of lymphatic transparent juices instead of red blood, and in this particular agree with the worm tribe. They have no distinct heart, external ears, openings at the nose, or nostrils, nor teeth in the mouth; and some assert that

they are destitute of voice. An insect is divided into segments, or joints, and covered externally with a tough or bony skin, which is either naked or clothed with down. The head is furnished with moveable antennæ, and the body with feet.

These animals are destitute of visible external organs of breathing at the mouth, their respiration is performed through the lateral apertures, or spiracles of the body and thorax.

They have two eyes, in which respect they agree with the larger tribe of animals: they have no cycelids, and their eyes are rarely placed on a pedicle; the diophsis is an exception.

The antennæ are situated on the head before the eyes; and are composed of an indefinite number of articulations; in genuine insects, the antennæ never exceed two. The cancri have a greater number, and many of the Linnæan apteræ have none.

The feelers are articulated, moveable, variable in number from two to six, and are affixed contiguous to the mouth.

The mouth is usually situated beneath the head.

The jaws are disposed transversely in the head, and move laterally, by which means they are distinguished from most other animals.

The trunk is placed between the head and the abdomen.

The abdomen is usually annulated with five segments, and is sometimes armed at the end with a sting.

The legs are usually six in number, and are attached to the trunk. Each leg consists of three distinct divisions, the thigh, shank, and feet.

The wings are either two or four; some of those with two wings only are protected by a shelly covering, as in the coleoptera.

Insects are oviparous; deposit their eggs in an impregnated state in general, and do not brood over them, or their young. Most insects undergo a triple transformation, the egg producing a grub or larva, which becomes, when full grown, a pupa, and the later producing the perfect fly. The sexes are male and female; there are also neuters in some species devoted to labour for the former. Insects cast their skins, and therein agree with reptiles. They are said to inhabit those plants on which they usually feed.

*Description of the component parts of Insects.*

The external parts of which insects consist are divided into four principal sections, the head, trunk, abdomen, and members, each of which require to be separately considered.

*Caput, or Head.*—Under this term is included the first, or principal organ, the head, properly so denominated in its collective form. This part is supposed to be the principal seat of the senses, as in all others of the larger and apparently more perfect animals. Internally it contains the medullary substance or brain; its exterior characters are, the mouth, eyes, stemmata, antennæ, front, vertex, and throat.

In some insects the head is very large in comparison with their body. The proportion between the head and body is not the same in all insects, even in the different stages of growth or transformation. In the caterpillars, which have this part horny, it is generally small before they moult, or change their skin, and becomes larger after each moulting.

This part is almost constantly distinct from the thorax: in the coleoptera it is connected close to the latter: the hemiptera offer many examples in which the head is slightly attached, as in the genera blatta, acheta, phasma, mantis, &c.: in the lepidoptera order the head is not always very intimately situated to the thorax; there is a small interval sometimes between which the articulation of the neck may be

seen, when the head is inclined downward. The succeeding order, neuroptera, afford numberless instances of the head being placed upon a slender ligamentous pedicle at a distance from the thorax: in hymenoptera and diptera the head is rather remote, sometimes being placed on a small tubercle in the anterior part of the thorax; and in the last, or apterous order of Linnæan insects, several of the genera are distinguished by having the head and thorax confounded with each other, as in scorio, aranea, monoculus, &c.

The connection between the head and thorax in insects subsists by one of two modes of articulation; the first, in which the point of contact is solid, and the motion depends upon the shape of this part, or another in which the articulation is formed by a ligament. In the articulation of the head by the contact of the solid parts, the head has commonly, at the part answering to the neck, one or two smooth tubercles, which are received into correspondent cavities on the anterior part of the thorax. This is exemplified in the genera scarabæus, lucanus, cerambyx, and most other coleoptera, and which hence have the power of moving the head backward or forward, and thus of directing the mouth downward. Another mode of solid articulation takes place when the posterior part of the head is rounded, and turns on its axis in a correspondent socket on the anterior part of the thorax, as in the brentus, &c. The axis of motion is then in the centre of the joint, and the mouth of the insect can be directed either upward or downward, or to the right and left. A third sort of articulation occurs when the head is truncated behind, and joins by a flat surface either to a tubercle of the thorax or to another flat and corresponding surface, as is seen in many of the hymenoptera and diptera. In some kinds of the Fabrician attelabi, this solid articulation is accomplished by another means: the head of these insects terminate behind in a round tubercle, which is received into a correspondent cavity of the thorax: the inferior edge of this cavity is notched, and thus confines the motion of the head to one direction.

The ligamentous connection of the head and thorax is shewn in the blatta, forficula, mantis, and several of the neuroptera. In this mode of articulation, the motion of the head is very extensive, and confined only towards the back, in which direction it is opposed by the projection of the back. The muscles which move the head are situated within the thorax: the membranes or ligaments extend from the anterior part of the collar to the surface of the occipital foramen.

*Brain, or Medullary Substance.*—According to the “*Fundamenta Entomologiæ*,” it was the idea of Linnæus, that insects have no brain in the head; an opinion often repeated since his time, but which, from the observations of the ablest physiologists of the present period, proves to be unfounded. Linnæus does not deny the existence of a medullary thread in this part of insects, but states that he never could discover it to be organized; and hence, he says, the hippobosca equina, or horse-fly, will run, live, nay even form an union with the opposite sex, after being deprived of its head, to say nothing of many others, which are capable of living for a considerable while in a decapitated condition. From the anatomical investigations of Cuvier it is, nevertheless, sufficiently obvious, that independently of a nervous medullary thread, insects have a brain distinctly organized, from which this thread and other nerves arise, and that its seat is in the head, as in the more noble tribe of animals. The existence of a true brain in insects was believed by many writers before the time of Linnæus, and by some after; but, generally speaking, the opinion of this celebrated naturalist was assented to, and enquiry ceased, till its consideration

was revived by Fabricius, and the physiologists of France, the most distinguished of whom is Cuvier, and from the result of their observations it may be affirmed, that insects, as well as most other animals, have a genuine brain.

Fabricius is reputed to be the first who discovered the true brain in insects. That Fabricius asserts the fact, and that as an entomologist his assertion was successfully opposed to the opinion of Linnæus in this respect, is not to be denied, yet the merit of discovery is by no means due to this writer. His observations on the brain, the organs of hearing, and other sensations of insects, were made chiefly on the lobster or cray-fish, animals of the crustaceous kind, and which, though in some respects analogous, we do not admit to be of the insect race. But if they were, can we have so entirely forgotten the anatomical investigations of cancer attack by Roesel, as to allow Fabricius the credit of discovering those very organs which he describes many years before; and if he really observed those organs in genuine insects, can we overlook the laborious anatomical enquiries of Swammerdam, or the minute researches of Lyonnet, in which the existence of such an organ is rendered manifest, with no other view than to award the merit of its discovery to Fabricius?

No physiologist whatever has pursued this interesting subject of enquiry so far as Cuvier. This attentive and skilful observer examined a considerable number of the different tribes of insects, in order to ascertain their internal organization, and has established, beyond dispute, if any doubt could still remain, that insects have a brain in the head. From Cuvier we also learn that the brain is not constantly of the same structure in all insects; in some tribes this organ consists of one lobe, in others of two, and in others again of four; and the nerves arising from them differ also very materially in different families, and sometimes even in species. But besides this dissimilarity, there is another circumstance infinitely more remarkable, the form of the brain and medullary nerves in certain insects, are ascertained to undergo a considerable change, as well as the external organs, in passing from the larvæ to the perfect state. The most extraordinary of these deserve notice, and the circumstance being stated may stimulate others, perhaps, to a farther enquiry, in the result of which, it is apprehended, a similar change, will be observed, in a far greater number of the insect race than may be at present conceived.

*Brain in Coleopterous Insects.*—The larva of a large beetle, common in Europe, and known by naturalists under the name of scarabæus nasicornis, affords a favourable opportunity for the ascertainment of this fact; it is of a large size, and the change it undergoes in passing to the winged state is very considerable. The brain in this larva is situated under the great scale which covers the head, immediately above the origin of the œsophagus. It consists of two approximate lobes, which are very distinct at the front and back part. Four nerves arise from the anterior part, two on each side, which are lost in the cirri and parietes of the mouth, one pair of nerves arises also from the lateral and somewhat posterior part of the brain, which, embracing the œsophagus, proceeds below to form a nervous cord; and another pair is produced from the lower surface of the brain. In the perfect insect, the nervous cord presents a very conspicuous difference; in the larva there is only a single ganglion, but the perfect insect has several, and which are very distinct. The first is situated above the condyle; it proceeds from the two posterior filaments of the brain, and is distributed to the muscles which move the head on the corselet. Its posterior part produces two filaments, which pass into the breast, where they unite towards the middle,

middle, and form a triangular ganglion, from the sides of which three pairs of nerves arise, and are distributed to the muscles. Its posterior angle detaches two parallel nerves which proceed into the breast, where they form a third and fourth ganglion, situated very near each other, and apparently divided into two lobes by a longitudinal furrow. All the other nerves of the body proceed from these two ganglia, by an irradiation precisely in the same manner as in the larva.

The nerves in the larva of the stag beetle (*Lucanus cervus*) differ greatly from that of the foregoing insect. The brain consists of two contiguous and almost spherical lobes, which produce four nerves anteriorly; two beneath and two behind, which latter form a collar round the œsophagus, and uniting underneath compose the nervous cord of the body. The cord is formed of eight ganglia, and extends to the ninth ring of the body. In the perfect state the brain consists likewise of two approximate lobes of a spherical form. There are also two ganglia on the lateral parts of the brain, which are almost as large as each of the lobes: in form they resemble a pear, and rest on the brain by their base: the two anterior pairs of nerves arising from the brain terminate in the palpi and other parts of the mouth. The brain produces also two very long and slender nerves behind, and the disposition of the nerves arising from the various parts differ very much from those observable in the larva.

The nervous system of the larva of *Hydrophilus piceus*, or great water beetle (*Dytiscus*, Linn.), will serve to illustrate those of an extensive number of other coleopterous insects, such as the larva of *Cerambyces*, *Dytisci*, *Carabi*, *Staphylini*, &c. Some little variation will be found, but the analogy is very conspicuous. The brain in the larva of this insect is situated in the head above the origin of the œsophagus; it is formed of two lobes, which lie very close together. From its anterior part it detaches some filaments to the palpi, the antennæ, and the parietes of the mouth. Its lateral parts produce two cords, which surround the œsophagus, and which are the origin of the nervous cord situated inferiorly. The chief nervous cord is composed of ten ganglia, each of which produces three pairs of nerves, which are lost in the muscles of the abdomen. In the perfect insect the brain consists of two spherical bulbs, which are closely united. The lateral parts give origin to the optic nerves. The anterior part of the brain detaches some filaments intended for the parietes of the mouth. In the same place is also a small spherical ganglion, which seems to belong to the recurrent nerve that accompanies the œsophagus. The brain in the larva of *Dytiscus marginalis* is different from that in the larva of *Hydrophilus piceus*, although those two insects are so closely allied in genera; in the latter it is spherical, and consists of a single lobe, it is situated in the head above the origin of the œsophagus: its anterior part produces some filaments for the mouth, and its lateral parts the two optic nerves: the latter are composed of two parts, which are very distinct in form. That portion next to the brain is of an oval figure, pointed at the extremity which joins the brain, the other extremity is rounded, and produces a slender nerve, which passes directly to the eye.

*Hemiptera*.—The structure of the nervous system in the larvæ of hemipterous insects does not often differ very sensibly, it is said, from that which is exhibited in the perfect insect to which they respectively belong. But the small number of this tribe already examined do not authorize us to speak on this subject with much confidence. A considerable difference prevails in this respect between the perfect insects of some opposite genera, as appears from those which Cuvier

describes. In the cock-roach, *Blatta americana*, the brain is composed of two lobes, separated by a very distinct notch anteriorly. The optic nerves arise on the sides, and its anterior part detaches some filaments to the parietes of the mouth, and to the instruments of manducation. The nervous cords, which form the medulla, arise from its inferior surface. In the great green locust (*Gryllus viridissimus*) the brain is situated in the head above the œsophagus; it consists of two lobes, which are pyriform, united at their base, and prolonged at their other extremity into an optic nerve for the eye of each side. The anterior part also produces two nerves of a pyramidal form, the base of which rests upon the brain. The brain of the mole-cricket (*Acheta gryllo-talpa*) is composed of two rounded lobes, which are particularly distinct at the posterior part. The nervous system of the water scorpion (*Nepa cinerea*) is different. This consists of three ganglia, the first of which (properly the brain) is situated in the head. It is formed of two approximate pyriform lobes, which touch each other at the base, while their summits are directed obliquely forward towards the eyes in which they terminate: the middle and anterior part of these lobes also produce filaments for the parts of the mouth; the third, which is more voluminous than the brain, lies near the base of the second pair of legs.

*Lepidoptera*.—The nervous system of caterpillars, or lepidopterous insects in the state of larvæ, consists of a series of thirteen principal ganglia, which furnish filaments to all the other parts of the body. The first of these ganglia is what may properly be considered as the brain: it is situated in the cavity of the head above the œsophagus, and consists of two round tubercles, which are concave beneath, and correspond to the convexity of the œsophagus. This ganglion communicates with the rest of the nervous cord by two thick filaments, which embrace the œsophagus, and which are united below it to the anterior and lateral parts of the next ganglion; and it besides produces eight pairs of nerves. The first partly unites with other filaments; produces some for the œsophagus, and forms several remarkable ganglia below the lower lip. The largest and most posterior, which Lyonet has named the first frontal ganglion, is prolonged behind into a thick recurrent nerve, which is continued the whole length of the body contiguous to the back. The second pair of the brain appears chiefly intended for the antennæ, though it furnishes several filaments to the neighbouring parts, and the others for the more remote portions of the body. These observations are from Lyonet, and relate principally to the larva of the goat moth (*Phalæna cosus* of Linnæus.) Few of the lepidopterous insects in the winged state have yet been examined for the purpose of ascertaining the structure of the brain. In *Phalæna dispar* this organ is almost spherical; there is, however, a longitudinal furrow on the middle line. Its anterior part produces some exceeding slender nerves. There are also two large optic nerves on the sides which proceed into the concavity of the eye, where they terminate by a bulb, from whence arise a great number of filaments.

*Neuroptera*.—In the larva of the lion-ant, (*Myrmellon formicarius*) the nervous medulla, proceeding from the brain in the head, consists first of two ganglia, which are composed of two lobes situated close together, and are placed in the thorax; the remainder of the nervous medulla, consisting of eight ganglia placed in very close series, and each formed of two lobes, is contained in the abdomen. The larva of the ephemera has eleven ganglia, exclusive of the brain, which furnishes two large optic nerves. The larvæ of the libellulæ, or dragon flies, have a small two-lobed brain, which produces optic nerves, larger or smaller in different species.

The Fabrician genus *æstha* has the largest. The rest of the nervous system forms a series of ganglia of different sizes. In the *æstha* the thorax contains six, the two last of which are the largest, and there are seven small and equal ganglia in the abdomen. In the winged state the brain is formed of two very small lobes, and the optic nerves are dilated into the form of two very large plates, which have the figure of a kidney, and which is spread upon all the inner surface of the eye next the head. The remainder of their medullary cord is exceedingly slender, and furnished with twelve or thirteen small ganglia, the last of which is, as usual, connected with the organs of generation.

*Hymenoptera*.—The brain in the larvæ of some kinds of tenthrédines, which have the head large, is broad and short, and seems to consist of four bulbs of equal magnitude, and the form of which is nearly spherical; the two external ones serve as the base of the optic nerves, which are slender, and enlarge a little at their other extremity. The first ganglion is produced by two very small nerves, which arise from the inferior surface of the brain, and which, after having embraced the œsophagus, unite under the first ring of the body; it furnishes filaments to the muscles of the feet, and terminates posteriorly in two other nerves, which, at the distance of one line, produce a second ganglion, and so on in succession: the nervous cord is in this manner formed of eleven ganglia, exclusive of the brain: all the ganglia are of a roundish form, and diminish in thickness as they recede from the head. The brain of one of the hymenopterous tribe in the winged state (the common bee) is rather small, and is divided into four lobes. It produces the nerves which are distributed to the different parts of the mouth, and the two large optic nerves which are dilated, and applied behind each eye, as in the libellulæ. There are afterwards seven ganglia, three of which are in the thorax and four in the abdomen. The nerves of the last chiefly supply the sexual organs.

*Diptera*.—The nerves of the larvæ, in some of the Linnean muscæ, as *m. chamæleon*, &c. (*stratiomys*, Fabr.) have some resemblance to those of the larvæ of *scarabæus nasicornis*. The brain is formed of two lobes placed close together and almost spherical; it is situated above the œsophagus, on a level with the second ring of the body. A number of small nervous filaments arises from its anterior part, and they are distributed to various parts of the mouth. The posterior part of these two lobes sends forth two thick branches, which embrace the œsophagus, and form the origin of the nervous medulla. This nervous cord is very short, and in diameter one half less than that of the brain. It consists of eleven ganglia placed very near each other, each of which produces one pair of nerves.

A more singular appearance is exhibited in the structure of the nervous system of *musca putris* than that just described. The brain is situated immediately above the origin of the œsophagus behind the head; it is very large in proportion to the rest of the body. The anterior part is notched, posterior rounded, and appears altogether as if formed of two lobes. A pair of nerves arises from the anterior part of the brain, proceeds forward, and is distributed to the mouth. These nerves become conspicuously large previously to distribution. Posteriorly the brain presents an aperture which affords a passage for the œsophagus: the nervous part, situated at the sides, may be regarded as cords which produce the medulla, and all below the œsophagus as the medulla itself.

*Musca tenax* (Linn.) in the perfect state has a small brain, formed of two lobes, which are situated very near together, but distinguished by a longitudinal furrow; the anterior part produces a large nerve, which is afterwards distributed to

the antennæ and the proboscis. In *æstus crabroniformis* is a single cord uniting the abdominal ganglia, which are six in number. The brain itself is similar to that of the syrphus (as in *musca inanis*, &c.) but the bulbs formed by the optic nerves are still broader in proportion to the extent of the eyes they have to invest.

*Aptera*.—In the great centipede, *scelopendra moritans*, the brain has a very singular form: the two lobes of which it is composed are almost spherical; the optic nerve is produced laterally and is very short. The filaments are four in number, but two nerves arise anteriorly which are so very thick, that they appear part of the brain, to which they are equal in diameter. These nerves are particularly intended for the antennæ, into which we observe them enter. The two cords which embrace the œsophagus proceed directly downward, and form a large ganglion at the union of the first ring with the head. The first ganglion produces two nerves posteriorly, and several towards the sides. A ganglion, precisely of the same shape, is placed above each of the articulations: thus there are in all twenty-four very distinct ganglia in this insect, from each of which are detached three pairs of nerves.

*Mouth*.—In order to afford some idea of the amazing difference that prevails in the structure of the several parts or organs which constitute the mouth, it will be only requisite to observe that the classification of all insects, in the Fabrician system, is founded on this character. There are ten principal parts of which the mouth consists; and it is from the relative proportion of each, from the dissimilarity in the form, position, variation in number, or occasional peculiarities, that the most permanent characters are deduced. These parts have one disadvantage: they are generally small, and from this circumstance have not been so universally adopted in the arrangement of insects as they would otherwise. Without, however, bestowing some little attention to these organs, it is impossible to distribute insects into their natural order with any great degree of certainty.

The organs of the mouth were slightly regarded by Linneus; and to this cause alone we may attribute some few serious errors in the works of that naturalist. The parts he describes are the rostrum (or proboscis); maxilla, lingua, and labium superius. Some of these are not sufficiently discriminated; his rostrum and proboscis are not different; the maxillæ are confounded with the mandibulæ; and the labium superius is not, as the expression implies, the upper lip of the insect, this latter part being situated under it. Fabricius defines these parts with more precision, as he derives his essential characters from them. In the arrangement of Olivier, in the works of Latreille, and most other modern writers on entomology, the essential characters are established chiefly on the peculiarities of these organs.

The ten principal parts of which the mouth consists are the following.

*Labium superius*, or upper lip: a transverse, soft, moveable piece of a coriaceous or membranaceous nature, known from its situation at the anterior or upper part of the mouth. This part is very distinct in many of the coleoptera, and in the gryllus, apis, and some other genera. Linneus sometimes confounds the upper lip with the clypeus or shield of the head; and similar instances occur in the works of Fabricius. These two parts may be distinguished by one invariable character; the clypeus is fixed, and forms a portion of the head; the upper lip is moveable.

*Labium inferius*: the piece which terminates the mouth beneath, and which is sometimes lengthened, so as to form the instrument called ligula. It is soft, flexible, usually

bifid, and has the posterior pair of feelers placed at the base.

*Mandibulae*, mandibles: two hard pieces, in substance resembling horn, which are placed one at each side of the mouth, below the upper lip. These have a lateral motion, while the upper and lower lip move up and down, as in other animals. These differ from the maxillæ, with which they are sometimes confounded, by not having any of the palpi or feelers attached to them. In rapacious insects, these are larger and more powerful than in those which perforate wood; and the latter again have stronger mandibles than insects which feed only on herbage or leaves.

*Maxillæ*: two small pieces of a somewhat membranaceous consistency, and in figure different from the mandibles. These are commonly indented at the extremity, and nearly all ciliated at the inner edge. They are placed under the mandibles, and above the lower lip; their motion is lateral. In those insects which have more than one pair of feelers, the posterior ones take their origin from the sides of the maxillæ.

*Galeæ*.—Shields of the mouth, two membranaceous appendages, usually of a large size and cylindrical form, placed one on each side, at the exterior part of the jaw, and which cover and protect the organs of the mouth, conjointly with the lips. The galeæ are inserted at the back of the jaws, as is well exemplified in the gryllus tribe.

*Organs of Taste.*

These appertaining of course, like the foregoing, to the mouth, and of which they constitute the most material part, admit of considerable variety in their formation, and in some particular tribes differ so greatly as to have obtained distinct names in the works of entomologists, according to their precise form; such, for example, as ligula, lingua, rostrum, proboscis, and haustellum.

*Ligula*.—This is the part considered by many authors as the lower lip; its situation is immediately under the jaws; and it consists of a single piece, which is of a soft texture, often bifid, and, if attentively examined at the base, will be found of a horny substance.

In the coleoptera, and some of the hemiptera, as the blatta, phasma, gryllus, &c. this tongue terminates at the point in a membranaceous substance: its form is extremely various in the different genera. The hymenoptera and some neuroptera have the tongue or ligula situated in the same manner; but it is in these concave, and is frequently prolonged into a sort of proboscis, which sometimes exceeds the length of the whole body. It is membranaceous, but of a soft and spongy texture, and well suited for receiving the impressions of taste. This kind of tongue is extremely well exemplified in the bee.

*Lingua*: tongue, the involuted tubular organ which constitutes the whole mouth in lepidopterous insects. This is of a setaceous form, and either very long, as in the papilio and sphinx genera, or short, as in most of the bombyces and other moths. It consists of two filamentous pieces, which are externally convex, concave within, and connected longitudinally by a suture along the middle above and beneath. These in uniting form a cylinder, through which the nectareous juices of the flowers on which these insects subsist are drawn up with facility. These two pieces are not very closely united, and may be separated by means of a needle point. When the insect takes its food, this tube is exerted; at other times it is rolled up spirally between the palpi.

A curious circumstance is mentioned by Degeer, relative to the tongue of the butterfly. Having cut off the

tongue of a papilio antiopa, almost as soon as it was emancipated from the chrysalis, it moved and rolled itself up at intervals for a considerable time: an hour after it had been cut off it repeated the same motions, recommencing them every time it was touched. It was observed that the same effect did not follow, if the butterfly had been liberated from the chrysalis for a few days.

*Rostrum*, or beak: the part which forms the mouth in many of the hemipterous order of insects. This instrument is moveable, articulated, and bent under the breast. Within this beak is hollow, and contains, as in a sheath, three or more very fine and delicate bristles, the points of which these insects introduce into the body of the animal, or substance of the plants, from which they draw nourishment. The rostrum is conspicuous in the genera cicada, nepa, and cimex.

*Proboscis*.—The trunk is inserted in place of the mouth, in most dipterous insects. It is rather fleshy, retractile, of a single piece, and often cylindrical; the end forming two lips, which are of a soft substance, and from the delicacy of their teguments must possess the faculty of taste in a very high degree.

*Hauſtellum*.—Formed of two or more very small and delicate filaments, inclosed in a sheath of two valves.

Lingua, rostrum, and proboscis, are Linnæan terms: the first is adopted according to the definition of that system; the two latter are synonymous with Linnæus. Ligula is a Fabrician expression, indicating the lower lip.

*Palpi*.—Feelers. These are the small, moveable, filiform organs, or appendages, placed at each side the mouth in the generality of insects. In some respects they resemble the antennæ, but are more distinctly articulated. They vary in number in different insects, being either two, four, or six, and are commonly inserted at each side the exterior part of the jaw. In those which have only one pair, they are usually situated on the upper lip; when two or more, the posterior ones are generally on the lower lip; and in some insects furnished with a sucking trunk, they are oftentimes found inserted at each side of that organ. These feelers are composed of several joints, the number of which vary. Like the antennæ, to which they bear analogy, they are endowed with powers of motion, but still more extensively. They also serve, like the antennæ, as an essential character in the construction of genera; and from their situation, the number of joints, termination, and relative proportion and size, are exceedingly useful for that purpose.

These feelers, as their name implies, are considered as the organs of touch; and this is conceived probable, because the insect agitates these parts, and presses its food with them before it begins to eat. Some have supposed them to be the organs of hearing; and others of a sense peculiar to insects, which we are ignorant of. It has been ascertained from experiment, that they are not absolutely necessary to the life of the insect, and that it even sustains their loss without much apparent inconvenience. Feelers are not common to all insects. There are many whole genera destitute of them; as, for example, the fulgora, cicada, the several genera of the Linnæan cimices, nepa, notonecta, and various others.

Certain kinds of insects are provided with feelers, both in the larva and perfect state, as is particularly exemplified in the dytiscus and hydrophilus genera, and again in the libellule; and it is worthy of remark, that these organs appear to be more immediately useful to the carnivorous tribes of insects than to those which feed on plants.

*Olfactory organs*.—Nature has denied the insect race that particular part which is properly called the nose; and it is

## ENTOMOLOGY.

further evident, that there is no organ within the head appropriated to the sense of smell. From analogy, and comparison with other animals, naturalists have been led to seek this organ in the head: and as insects afford the most convincing evidence of being possessed of this faculty, some have placed it in the antennæ, and others in the feelers; neither of which, from attentive examination, appears calculated for this purpose.

It is sufficiently clear that insects possess the faculty of smell, if not in a very eminent degree, and that in many respects they are rather guided by this sense than by the force of instinct. Insects discover their food at a great distance, and, as it is supposed, by this means; and it is concluded likewise, that butterflies and moths are directed by the same sense to the discovery of their mates. A female of *phæna quercus* (egg-moth), inclosed in a box, and thus exposed in an avenue of a wood, will attract the males in numbers to the same spot; and though she cannot possibly be seen, they will appear fully sensible of her presence. Admitting that these circumstances may be otherwise accounted for, one argument at least bears strongly in its favour, namely, that of the flesh fly (*musca vomitoria*) being so far deceived by the similarity of odour, as to lay its eggs on plants of the *stapelia* genus instead of animal substances. These insects, as the name implies, subsist in the larva state on flesh, preferring that which is putrid, or hastening to the stage of putrefaction, and from whence, in consequence, a powerful odour arises. The plants of the *stapelia* genus have the same smell; and the parent insect, misled by this means, actually deposits her eggs on these plants.

As instinct never errs, though judgment may, it is a natural inference that the insect is not in this instance under the controul of instinct, but of her own will, because otherwise she would not fail to lay those eggs in flesh, where the larva, when hatched, would be provided with food; while, on the contrary, the plants resemble this food only in its offensive odour, and thus, when hatched, the infant brood inevitably perish. Does not this afford presumptive evidence at least, that the insect is directed to these plants by the organs of smell?

If insects then evince such apparent proofs that they do possess this faculty, and that it appears likewise the seat of this faculty does not reside in the head, it must be sought after in some other part. The organs of smell, in all animals which respire air, is situated at the entrance of the organs of respiration: from this circumstance it is conceived most likely that the respiratory spiracles on each side the body must be the true organs of that sense. This idea was advanced by Baister; yet it seemed to imply such an inversion in the ordinary course of nature, that it gained little credit. Of late years the same opinion has obtained the concurrence of the best anatomists. Cuvier is decidedly in favour of this conclusion, and, in addition to the reasons hitherto stated in its support, observes, that the internal membrane of the tracheæ appears well calculated to perform this office, being soft and moistened; and that the insects in which the tracheæ enlarge, and form numerous or considerable vesicles, are those which seem to possess the most perfect sense of smell. Olivier endeavours to maintain that the palpi or feelers, and also the antennæ, are the olfactory organs in insects.

*Eyes.*—Most insects have two eyes. These are placed in the anterior part of the head, and vary very much in their external figure in different tribes. Some of the Linnæan insects of the apterous-order have a greater number, the scorpions have eight, and the spiders from six to eight, and

there are besides other genera in which the eyes amount to more than two.

This pair of eyes in the insect race is of a compound kind, while those of the scorpion and spider are simple, and in this respect the difference is very remarkable. The compound eye is one of the most extraordinary deviations from the ordinary course of nature in the conformation of the organ of sight; the simple eyes approach much nearer those of other animals. By compound eyes we mean those kinds which are reticulated, and when magnified are found divided into a great number of compartments, and of these every genuine insect appears to possess two. Besides these eyes, many of the neuropterous and hymenopterous families have three small shining convex points placed in the middle of the head, and called by entomologists *stemmata*, the utility of which has never been ascertained. The extreme minuteness of these organs does not allow the comparative anatomist the means of dissecting them, but we still think they can be no other, than organs of sight. Should this appear doubtful, because we observe them in those insects, which are besides furnished with a pair of eyes of the compound kind, it should be recollected that scorpions and spiders, as before-mentioned, have several more eyes than a pair; and if, on the other hand, the simplicity of their structure be considered as an argument against this conclusion, let it be observed that they possess every character in their form, appearance, situation, and immovability, which the only kind of eyes these creatures are furnished with are known to possess. We, indeed, conceive it very probable, that those three shining points, called *stemmata*, are truly organs of sight; and that, consequently, many insects which appear to have only two eyes, have in reality no less than five.

The compound eye in insects is so very different from that of other animals, that it would be difficult to persuade ourselves of its being an organ of sight, had not experiments, purposely made, demonstrated its use. If we cut out, or cover with an opaque matter the eyes of a libellula, or dragon fly, it will strike against walls in flight. The wasp is said to ascend perpendicularly in the air till it completely disappears, when the compound eyes are treated in the same manner, and to remain perfectly immovable when both the compound eyes and the *stemmata* are covered; in the first case it seems to follow the direction of its flight upwards, in the other to be deprived entirely of the visual organ, and uncertain whither to direct its flight.

The compound eyes are generally convex, and when viewed by the microscope exhibit an innumerable multitude of hexagonal facets, slightly convex, and separated from one another by small furrows, which frequently contain fine hairs, more or less long. These facets give, to the naked eye, the appearance of net-work, and amount to a greater or less number in different insects. Leeuwenhoek counted 3181 in the eye of a beetle, and in that of the common house fly about 8000.

These facets form altogether a hard elastic membrane, which, when freed from the substances that adhere behind, is very transparent. Each of these small surfaces may be considered either as a cornea, or a crystalline, for it is externally convex, and concave internally, but thicker in the middle than at the edges, and it is also the only transparent part in this singular eye. Behind this transparent membrane is a substance, which varies greatly as to colour in different species, and which sometimes forms, even in the same eye, spots or bands of different colours. Its consilience is the same as that of the pigment of the choroides; it entirely covers the posterior part of the transparent facets, without leaving any aperture

aperture for the passage of the light. Behind this pigment we find some very short white filaments, in the form of hexagonal prisms, situated close to each other, like the stones of a pavement, and precisely equal in number to the facets of the cornea; each penetrates into the hollow part of one of these facets, and is only separated from it by the pigment mentioned above. If these filaments are nervous, we may consider each as the retina of the surface behind which it is placed; but it will always, in the opinion of Cuvier, remain to be explained how the light can act on this retina through a coat of opaque pigment. This multitude of filaments, perpendicular to the cornea, have behind them a membrane, which serves them all as the base, and which is consequently nearly parallel to the cornea: this membrane is very fine, and of a blackish colour, which is not caused by a pigment, but extends to its most intimate texture; we observe in it very fine whitish lines, which are trachææ, and which produce still finer branches that penetrate between the hexagonal filaments as far as the cornea: this membrane by analogy Cuvier calls the choroides. A thin expansion of the optic nerve is applied to the posterior part of the choroides. This is the real nervous membrane, perfectly similar to the retina in red-blooded animals; it appears that the white filaments, which form the particular retinæ of the different ocular surfaces, are productions of this general retina, which perforates the membrane named choroides by a multitude of small and almost imperceptible holes. To obtain a distinct view of all these parts, it is necessary to cut off the head of an insect which has the eyes of large size, and dissect it behind, each part will then be removed in an order, the reverse of that above described.

The construction of these compound eyes is admirably adapted to the convenience of the insect, for as the eyes of insects are immoveable, they would have lost sight of many objects, if their eyes had been framed like those of other animals, but by these means they can easily view surrounding objects. It seems a false conclusion that as each of the facets which compose the compound eye is a distinct organ of sight, any single object must appear multiplied as often as there are facets; it is, on the contrary, far from improbable, that as objects do not appear double to our eyes, but that the visual organ is strengthened, and many illusive appearances are corrected by the use of both, so the numerous inlets to sight in an insect may increase their field of view, and be productive of other advantages, of which we are ignorant.

*Stemmata*: the three smooth, glossy, hemispherical dots, situated at the vertex of the head, and which, as just observed in speaking of the eyes, are supposed to be organs of sight. These are most conspicuous in the hymenopterous order of insects.

An experiment made by abbé Catalan tends to confirm the truth of this conjecture. With the view of observing whether an insect could see equally well with both the eyes and stemmata, he covered the reticular eye of a fly with fluid pitch, leaving the stemmata open; he then put it under a glass, where it ran up and down without striking against any object, and when he lifted the glass, it flew away towards the window. He took another fly, and covered with pitch the stemmata, leaving the reticular eyes open, and found that with these it saw equally well as before. Lastly, he took a third fly, and covered both the reticular eyes and the stemmata, and this he found completely blind; it walked slowly under the glass, and when removed would not venture to fly. *A. & Erudit. A. D. 1682.*

*Antennæ* are those delicate moveable horns which ap-

pear on the fore part of the head in all perfect and genuine insects; and which, in many instances, are very remarkable for their beauty and elegance of structure. The antennæ are extremely diversified in form, and vary considerably in their proportional dimensions in different tribes; and for this reason are considered by entomologists of material consequence in distinguishing the various orders, genera, and species. These parts are always articulated, or consist at least of more than one joint, including the base, and most commonly are composed of a far greater number; few less than eight, ten, or twelve, and some amounting to twenty, or even more. This articulated structure of the antennæ is of infinite utility to the insect, as it is thereby enabled to move these organs in every direction their wants or wishes may require.

Antennæ are not entirely peculiar to insects; the crustaceous animals possess the same organs, though in other respects they differ so essentially, (see article *CANCER*;) as do likewise some of the apterous order of Linnæan insects, which modern naturalists exclude from this class. Nor will it be amiss to observe that, even according to Linnæus, many of his apterous insects are destitute of antennæ, and are consequently inadmissible on this account, upon his own definition, into the system of entomology. Spiders and scorpions are of the latter description. The organs termed antennæ are easily distinguished from the tentaculæ of vermes, by having a shelly covering, and from the palpi or feelers of insects, the latter being more numerous, and situated at the mouth. The Linnæan and Fabrician entomologists admitting the cancer, and other crustacea among the insect tribes, allow four, or in some cases even six antennæ to this race, but as we refer these to another class, we apprehend that the number of antennæ in all genuine insects invariably amounts only to two. Those insects which have attained their last state, and are therefore denominated perfect, and which possess six legs, are always provided with two antennæ. It is true that the larvæ of many insects are not furnished with these organs, yet they are still genuine insects, because in their complete state they possess them; spiders and scorpions on the contrary, with all their organs complete, have no antennæ. A very considerable number of insects, even in the larva state, are not deficient in these organs, and in many, though not in all, there is no difference whatever between the antennæ of the larva and perfect insect. The genera blatta, gryllus, mantis, phasma, cimex, and various others of the hemiptera order, are furnished with antennæ, which exactly resemble those of the same species in their perfect state.

No writer, who has attentively regarded the structure of the antennæ in insects, has hitherto pretended to determine precisely the purpose for which nature has designed them, and those who have not very maturely considered them cannot possibly be competent to decide such a doubtful circumstance. We know of nothing analogous to these organs in larger animals whose manners we might be supposed to have a better acquaintance with, and it is not therefore by analogy that this point can be determined. Some naturalists conceive that they are appropriated to a feeling more delicate than our own, and that they are sensible to the least motion or disturbance in the ambient fluid, or that they are the organs of some sense unknown to us, and of which we cannot consequently form the least conception. Some suppose they serve to sound, and occasionally to probe the earth on which they move, or that they are the organs of hearing, of feeling, or smelling, and by the means of which they distinguish their proper food. Each of these conjectures

is liable to objection, and can be considered as an opinion merely, while the real purposes of these organs may perhaps for ever remain unknown.

Though it is difficult even to conceive the immediate object for which the Creator has assigned these organs to the insect race, we must rest persuaded that they are intended to answer some very important destination in the economy of the animal, as the medullary nerves, arising directly from the brain, may be traced into these parts, and followed throughout their whole extent. In some insects also, which have the antennæ small, the palpi are observed to be very large, as if they were intended to answer the same purpose, or partake of the same sense, as the antennæ; and thus, by their mutual aid, supply the deficiency of antennæ. This will in some degree account, perhaps, for the manner in which nature seems occasionally to counterbalance the want of antennæ in the larvæ of certain kinds of insects which have palpi, but no antennæ; others in the same state have antennæ and no palpi. Many that are destitute of both the two first-mentioned kinds are those chiefly which prey on insects, and the latter such as feed on plants.

The antennæ, nevertheless, appear to us to be rather connected with the organ of hearing, than either that of feeling or smelling. The palpi, we have little doubt, are the organs of feeling, both from their texture, and the manner in which insects are oftentimes observed to make use of them in touching their aliments; and the organs of smelling in insects, however singular it may be imagined, we conceive to be no other than the apertures disposed on each side the thorax and body. By the organs of hearing, we do not mean to consider them as external ears, but as being in some manner auxiliary to the organ of hearing, the seat of which we suspect to be contiguous to the base of the antennæ, the spot in which the same organ has been discovered in the cray-fish. They may answer this and some other purpose likewise.

We have previously observed, that nothing can be distinctly inferred of the actual utility of the antennæ from analogy; nor do the purposes to which insects appear sometimes to appropriate them assist our conclusions in a satisfactory manner. Many insects, when they walk, fly, or take their food, have the antennæ directed forward; others, on the contrary, carry them inclining backward, like the cerambyces; some kinds lay them along their back; and others, as the elater tribe, dispose them on each side the thorax. The sphæges and the ichneumons bear their antennæ directly before them, and continually agitate them, whether in flight, when standing, or seizing on their prey. In others, the antennæ have little perceptible motion. Some insects are said to cover their eyes with their antennæ when they sleep; the diminutive size, compared with the magnitude of the eyes in most insects, will not permit us to believe that this is the principal object of their destination.

Notwithstanding the direct connection of the antennæ with the brain, insects, it has been affirmed, can undergo their partial privation, or total loss, without experiencing any sensible injury; and hence it has been concluded they cannot be necessary to the life of the insect. If the fact be true, the latter inference must surely be admitted, but this will not disprove their utility: nor will it discountenance the idea that the antennæ are requisite for some important end. We well know, that in the animal economy of larger beings, not only the medullary nerves may be in part destroyed, but even the animal be deprived of a portion of the brain itself, without sustaining mortal injury. The antennæ of insects may not be absolutely necessary to the life of the in-

sect, but are certainly so to its well being, and to the perfect exercise of all its functions.

The antennæ of the male insects generally differ from those of the females. It is principally the antennæ of the former that are plumose, or furnished with teeth, or tufts of feathers, while those of the female appear like a delicate thread, entirely smooth, or only slightly pectinated. This is observable throughout the moth tribe. In coleopterous insects the males are often distinguished by the superior size and beauty of the antennæ from the other sex. The antennæ are characterized by entomologists according to their structure under different names. Linnæus describes the following: 1, *Setaceæ*, those which gradually become taper towards the extremity; 2, *Filiformes*, such as are of an equal thickness throughout; 3, *Moniliformes*, are filiform like the preceding, but consist of a series of round knobs, like a neck-lace of beads; 4, *Clavatæ*, such as gradually increase in thickness from the base, and form a club at the end; 5, *Capitatæ*, like clavatæ, increase in thickness towards their extremity, but are distinguished from those by the form of their last articulation, which is larger and more rounded than the others; 6, *Fissiles* are like the last, but are divided longitudinally into three or four plates or laminæ; 7, *Perfoliatæ* are also capitatæ, but have the head divided horizontally, the plates being connected by a kind of thread passing through their centre; 8, *Pectinatæ* are those which have lateral appendages, like the teeth of a comb, or plume of a feather, as in the moth tribe. 9, *Aristatæ*, such as have a lateral hair, which is either naked, or furnished with lesser hairs, as in the musca genus. Each of these is also distinguished according to their length, as *breviores*, those which are shorter than the body; *longiores*, those which are longer than the body; and *mediocres*, such as are of the same length with the body, all which varieties are conspicuous in the Linnæan tribe of cerambycæ.

The structure of the antennæ in insects is of such vast importance in the definition of genera, species, and sexual distinctions, that it is to be regretted we have not a more comprehensive number of terms by which their particular forms might be minutely discriminated. Linnæus affords us some, the utility of which is universally allowed; others which he proposes require some revival and modification; and among the innumerable number of insects discovered since the time of Linnæus, the antennæ of many exhibit characters which cannot be expressed by any of those his work presents. Fabricius has others, but these, even in addition to those of Linnæus, are not adequate to the purpose.

#### *Organs of hearing at the base of the Antennæ.*

The organs destined by nature for the conveyance of sounds to the seat of the senses in the insect race have never been clearly ascertained. This can be attributed only, perhaps, to their minuteness, which defies investigation, except in some few of the larger kinds, and these even physiologists seem never to have examined. In the cray-fish the organs of hearing are exemplified by Fabricius and Scarpa. These were discovered within the head, at the base of the antennæ, through the hollow tube of which it is supposed the sound must be conveyed. Perhaps, from the analogy in certain respects, which this tribe of crustaceous animals bears to insects, it may be imagined that the organs of hearing in both are similar: this is very probable; but these two orders of creatures differ so essentially in several particulars, that we wish to express such an opinion with caution.

In the cray-fish the labyrinth of these organs is very simple, resembling a small purse, enclosed in a scaly cylinder open at both ends. The extremity by which this small cylinder joins the base of the antennæ affords a passage for the nerves into the purse. The opposite extremity is closed by an elastic membrane, which may be named tympanum, or, with more propriety, Cuvier thinks, fenestra ovalis. The air, or water in which the animal lives, acts immediately on this membrane, the external part of which is observable at the lower surface of the base of the antennæ. That insects are sensible of sounds, and, consequently, are furnished with organs of hearing, is demonstrated by numberless observations.

*Front*: the anterior or fore part of the head, the space between the eyes and the mouth.

*Clypeus*: shield of the head in coleopterous insects, the part corresponding with the front of the head in the other orders. In the beetle kind it is advanced more or less upon, or over the mouth, and in some forms a sort of cap, the rim of which extends so far over the head as to conceal the mouth beneath. The anterior edge of the clypeus is sometimes mistaken for the upper lip.

*Vertex*: the crown, or summit of the head.

*Gula*: that part which is opposed to the front of the head, usually called the throat.

*Trunk*: the second principal division of which an insect consists, comprehending that portion which is situated between the head and the abdomen. The trunk includes the thorax, collar, sternum, and scutellum.

*Thorax*: a term indefinitely applied sometimes to the whole trunk, the scutellum excepted: in a stricter sense it implies only the dorsal part of the trunk, and may be considered as expressive of that portion of the superior surface which lies between the head and the base of the wings. Linnæus is not so explicit as could be wished in his definition of the word thorax; according to this author, it is "the back part of the breast," and "upper part of the trunk between the head and scutellum," yet it is evident, from the dissimilar structure in this part of the trunk in different insects, that the definition requires rather more precision. It is not unusual in the specific descriptions of insects, both by Linnæus and Fabricius, to read of "thorax beneath," and "lower surface of the thorax," for the under-surface of the trunk; though both endeavour to establish it as a principle, that the word thorax applies to the back or upper surface of the trunk only. The appropriation of suitable terms, by which a thorax consisting of one, or of several pieces, may be discriminated from each other, is desirable. In some the thorax is of a single piece, as in the orders coleoptera and hemiptera; in that of lepidoptera it comprehends several segments, and a similar structure is still more conspicuous to view in the order hymenoptera. The first or anterior segment of the thorax in those consisting of several pieces has been sometimes called the collar; but in admitting this, we must by analogy define the coleopterous and hemipterous orders of insects as having no thorax. This will be rendered plain, when we consider that in the latter kinds of insects the first pair of legs arises from what is usually understood by the lower surface of the thorax; the interior segment in hymenopterous correspond with the whole thorax in the former, for the first pair of legs arises from it exactly in the same manner. In the former the thorax of a single piece is immediately succeeded behind by the scutellum, while in the hymenoptera and lepidoptera a large plane of one or more joints intervene between this true thorax and the scutellum; and it is to this last mentioned dorsal space that the term thorax is assigned. Hence it is evident that the lan-

guage of entomology in this point is not altogether consistent; because what we denominate the collar in hymenoptera, is the thorax in coleoptera, and in coleoptera we find nothing analogous to the thorax of the other order, except the collar.

The thorax in those insects, which have that part consisting of a single piece, or the first segment in such as are of a compound nature, have the first pair of legs arising from the lower surface, and it is in this part that the muscles that move the head, as well as this pair of legs, are said to be contained. The thorax in different kinds of insects varies considerably in form, and affords very excellent generic and specific distinctions. Some are armed with spines, others denticulated, margined, &c.

*Pectus*.—The breast is the third segment of the body, or that to which the four posterior feet are attached, and which is longitudinally divided at the anterior part by the sternum. The wings in lepidopterous, and most other insects, have their origin or base in the superior part of the breast. The wings and elytra in the coleoptera and hemiptera deviate a little from this, as they are placed more immediately on the back, than in a lateral position; the breast contains the muscles that move the wings, and give action to the four posterior legs. This part is capable of being compressed and dilated, the alternate motion of which is very evident in some insects of the butterfly or moth kind, when held between the fingers. The power of compression and dilatation is supposed to arise from the action of some very strong muscles, which seem to approximate the dorsal and ventral surfaces. They are four in number on each side, and differ very much in colour and texture from the other muscles, being reddish yellow, and extremely loose. It has been conjectured these muscles may assist the motions of the organs of flight.

*Sternum*, or breast bone.—By this term entomologists define that portion of the middle part of the breast which is situated between the base of the four posterior legs. This piece terminates insects anteriorly in a somewhat acute point, in others it appears rather bilobate, and in the far greater ends obtusely or in an obtuse lobe. There are few insects in which the sternum is remarkable, either from its magnitude or figure. In some of the coleopterous tribes, as hydrophilus and dytiscus, this part is most conspicuous.

*Scutellum*, or scutcheon (scutellum, Linn.) the lobe-like process, situated immediately at the posterior part of the thorax, in scutellate insects. The scutellum is not of the same form in all insects, yet its general tendency is towards a sub-triangular figure. In the coleopterous tribes it approaches nearest to this form; its deviations incline more or less to heart-shaped, with the tip pointing backwards. The same figure prevails in some of the hemiptera order. In the neuroptera, hymenoptera, and diptera, the triangular contour is still observable under various modifications, and most commonly with the posterior tip rounded off. Sometimes, as in several of the hymenopterous insects, the posterior end is armed with spines, or denticulations; this is, however, not usual, the scutellum in the far greater number of insects, whether terminating in a point, or rounded, is commonly unarmed. In point of size the scutellum is more variable than in figure; in some it is so small as almost to escape notice, merely forming a point at the extremity of the thorax, as we observe in certain kinds of the beetle tribe; in others it is very conspicuous; sometimes it is so large as to cover the middle of the back, and in others, as the scutellate kinds of cimices, and a few of the genus acrydium, it expands over the back, entirely concealing the wings and wing-cases, and covering the margin of the abdomen.

## ENTOMOLOGY.

*Abdomen.* is the last principal division, or posterior part of the body, and is connected with the breast, either closely, or at a distance, by means of a fillet. The abdomen is composed of annular joints or segments, the number of which vary in different insects. Each of these rings is pierced at the side with a single pore, which in some kinds are of conspicuous size, in others scarcely perceptible, and these are the orifices of the spiracles through which the insects breathe. The upper part of the abdomen is called by entomologists tergum; the inferior, or belly, venter. The opening at the posterior part of the abdomen is the vent, and the extremity in most insects contains the organs of generation: there are exceptions to the latter.

The total movement of the abdomen is not very obvious, except in insects which have that portion of the body pediculated, as in many of the hymenopterous genera. It has then a real joint, in which the first annulation is indented above, and receives a projecting process from the breast on which it moves. This joint is rendered secure by elastic ligaments, which have a considerable degree of force. Some muscles which arise within the breast are inserted into the first ring, and determine the extent of its motions. The partial motion of the rings is produced by very simple muscles, consisting of fibres which extend from the anterior edge of one ring to the posterior edge of that which immediately precedes it. When the dorsal fibres contract, the superior part of the abdomen being shortened, it turns up towards the back, but when the contraction takes place in the ventral or lateral fibres, the abdomen is inflected towards the belly, or directed towards one of the sides. The extent of the motion, however, depends upon the number of the rings, and their mode of junction. In the coleoptera, for example, the rings only touch each other by their edges, and the motion is very limited, but in the hymenoptera they are so many small hoops, which are incased one into another like the tubes of a telescope, so that scarcely half, and sometimes not above one-third, of their extent appears visible externally.

The form, connection, proportions, and appearance of the surface of the annulations of the abdomen, afford numberless specific distinctions; and so likewise do the appendices at the extremity of the abdomen.

The abdomen contains the intestines, the ovary, and part of the organs of respiration: it is affixed to the thorax, and in most insects distinct from it, forming the posterior part of the body. The abdomen is composed of rings or joints, by which means the insect can lengthen or shorten it, or even move it in different directions. The upper part of the abdomen is called tergum, the under part venter, the vent is in the posterior part.

*Tail.*—An appendage of any kind terminating the abdomen is usually denominated the tail. These appendages vary in figure considerably in different insects, and many tribes are totally destitute of them. They are supposed to be destined to direct the motion of the insect in flight, to serve for its defence, and for the deposition of its eggs. In some insects this tail is simple, (simplex,) and yet capable of being extended and withdrawn at pleasure. In others elongated (elongata). Some are setaceous (setacea) or bristle-shaped, as in the raphidia. Those termed trifeta have three bristle-shaped appendices, as in the ephemera. In some it is forked (furcata), as in podura. When it terminates in a pair of forceps it is called forcipata. In the blatta and others it is foliosa, or resembling a leaf. In the panorpa it is furnished with a sting, and is called telifera; this last may be more properly referred to the next.

*Aculeus,* sting, an instrument with which insects wound

and instil a poison. The sting generally proceeds from the under part of the last ring of the belly: in some it is sharp and pointed, in others serrated or barbed. It is used by many insects both as an offensive and defensive weapon: by others it is used only to pierce wood, or the bodies of animals, in order to deposit their eggs. In wasps and bees the sting is known to be retractile: in the scorpion fixed or immovably connected to the last segment of the body. In some insects it is the male only, and in others the female only, which nature has provided with this instrument: it is not frequently met with in both sexes of the same species; and the far greater number of insects have no such organ.

*Spiracles.*—These are the apparent orifices to the organs of respiration in insects, and which are known to many entomologists by the name of stigmata. The spiracles are a series of small apertures disposed along both sides of the abdomen: some few appear on each side the thorax, the remainder on the abdominal rings, every one of which is pierced on each side with a single aperture. Among the ancients it was generally believed that insects had not the power of breathing, and this they concluded because they have no respiratory organs, as in larger animals. The moderns are better informed; from the effects produced on insects by the pneumatic machine it is demonstrated, beyond dispute, that they do respire, though not in the manner of other animals. An insect placed in the receiver of this machine, upon the air being exhausted, becomes suffocated, and dies in a very short time; and the same result will be produced by closing the apertures of the spiracles with wax, oil, or other glutinous subjects, in a sufficient degree to preclude the passages of air through these openings, a fact which in itself may be regarded as conclusive, that these are the true organs of respiration in insects. They are also considered, and with much probability, as the organs of smell, as will be shewn hereafter.

Respiration being one of the most important actions in the life of every animal, it can be no matter of astonishment that great pains have been taken by naturalists to investigate the organs of breathing in insects; numberless facts contributed to prove its existence, but this being accomplished by means unknown in the other tribes of animals, it became an object of the greater solicitude to explain the manner in which it was effected. Malpighi, Swammerdam, Reaumur, and Lyonet, are among the number of the earliest writers on this subject, and from their observations it appears, that in the caterpillar there are two air-vessels, called tracheæ, which extend throughout the whole length of the insect; from these proceed an infinite number of ramifications, which are dispersed in various directions through the body; but the principal are those which form a direct communication between the tracheal vessels and the openings in the sides of the body. Of these there are nine on each side placed nearly at equal distances, one extremity terminates in the orifice of the spiracle, and the other enters the principal tracheal vessel disposed nearest, or on that side of the body. These lateral or spiracular vessels seem calculated for the reception of air; they are of a cartilaginous nature, and when cut preserve their figure; they are constantly observed in a temperate state of moisture, and communicate in many insects in the form of considerable vesicles, at their junction with the principal tracheæ.

Some writers have imagined, that though the air entered by the spiracles into the trachea, it did not come out by the same orifice, but was expired through a number of small holes in the skin of the caterpillar, after being conveyed to them through the extremities of the finer ramifications of the tracheal vessels. Others supposed, that the inspiration

and expiration of air through the spiracula, and that there was no expiration of air through the pores of the skin. Experiments were made to ascertain the truth of these opinions, by plunging the caterpillars into water, or anointing them with fat and greasy substances, either partially or entirely. The number of small bubbles which are observed to cover the surface of their bodies when they are immersed in water, is said not to arise from the air included in them, and then proceeding from them, but to be formed by the air which is lodged near the surface of their bodies, in the same manner that it is about all other substances. To render the experiment more accurate, and prevent the air from adhering to the skin, before the caterpillars were plunged into water, they were brushed all over with a hair pencil, and after this, it is affirmed, that few air bubbles were found on their bodies when immersed in water. The latter experiments were made chiefly by Bonnet, in order to ascertain the truth of some opinions previously advanced by Reaumur.

A caterpillar, according to Bonnet, may be retained a considerable time under water, without destroying the principle of life, and will recover soon after being taken out of the water, when it has lain till all apparent signs of life have ceased. A caterpillar partially immersed in water, or with two or three of the spiracles remaining in the open air, does not become torpid for a considerable time. One caterpillar lived eight days suspended in water, with only two of its anterior spiracles in the air. During this time it was observed, that when the insect moved itself, little streams of bubbles issued from the spiracles on the left side; from this and other experiments, however, it appeared, that the anterior pair of spiracles, together with the posterior pair, are of the greatest use in respiration.

It has been remarked, that "when we consider the great solidity of the cases or cones of certain kinds of insects; it is not easy to conceive how they can live several months under the earth in spaces so confined, and almost impervious to the air. If respiration was absolutely necessary to their existence, and indeed if they did respire, the same situation seems to preclude a continuance of the operation, as the air would soon be corrupted, and unfit for the offices of life."

But though it is difficult to ascertain the respiration of some insects at certain periods of existence, except from its effects in preserving life, which from analogy and collateral circumstances we are assured must depend on this cause, there are others to whom respiration seems necessary in a very extraordinary degree. Many instances of this might be adduced; but in no tribe is this more clearly shewn than in those of the aquatic kinds. There are a number of the latter which are obliged to keep their tails suspended on the surface of the water for this reason, and in proof of which, if they be plunged entirely under water, they become agitated and uneasy, first endeavouring to escape and rise again to the air, or, if prevented, shortly fall to the bottom and die. Some aquatic beetles resist the trial for a considerable time, while their larvæ can support the privation of air only for a few minutes. A remarkable evidence of the same kind occurs in the larvæ of *musca pendula*, which, though they live in the mud at the bottom of the water, have the power of extending the tube of the tail to a great length, in order to elevate it to the surface of the water; and the extremity of it is furnished with a tuft of fine hairs, which preserves that part buoyant on the surface, while the creature remains in a state of quiescence. A similar verticillated organ is placed at the tip of the tail in the larva of *musca chameleon*, which also lives in the water; this is expansile or retractile at the pleasure of the insect; when at rest the expanded tail rests upon the surface of the water, the re-

mainder of the body being suspended in that element with the head downwards, and when it is inclined to descend, it has only to retract or close up the rays of the tail to effect its purpose; an expansion of the tail will again raise the larva to the surface.

Upon anatomical examination, it has been found that the body of this last mentioned larva contains two large tracheal vessels: these air-vessels extend from the head to the tail, terminate in the respiring tubes, and receive the air from them. The larva quits the water when the time of its transformation approaches, and enters into the earth, where the skin hardens and forms a case, in which the pupa is formed: soon after the change, four tubes or horns are seen projecting from the case, which some suppose to be the organ for communicating air to the interior parts of the insect: they are connected with little vesicles which are filled with air, and by which it is conveyed to the spiracles of the pupa. The larvæ of gnats, and various other little aquatic insects of the same kind, are furnished with small tubes that play on the surface of the water, and convey the air from thence into the body of the insect.

Nothing can be more evident than that insects do not respire by the mouth, like other animals. To determine the respiratory organs in insects, and also to ascertain in what manner this function of life is performed, has been an object of solicitude with many. The experiments made with this view are numerous and conclusive, the result demonstrating, beyond dispute, that the spiracles are the apertures through which the air is drawn into the body. This may be inferred from the writings of Swammerdam, Malpighi, Reaumur, Muschenbrök, Degeer, and many others, who treat at large on this particular subject.

These spiracles exist in every stage of life, in the larva and pupa as well as perfect state. They are visible externally as a small knob of a roundish or oval form, slightly elevated and perforated in the middle: the aperture is usually oblong or subovate, and is the orifice of the channel which communicates with the trachea, one of which is disposed lengthwise on each side of the body.

The extreme tenacity with which many insects retain life, while deprived of air, seems to indicate that they exist much longer without the benefit of this renovating fluid than most other animals; and that in certain cases they may endure a temporary suspension of the functions of respiration. But nevertheless every experiment tends to confirm the fact, that so far as respiration is necessary, it is performed only by means of these spiracles, the closing of which, to the total exclusion of the air, will at length destroy the vital principle.

Lyonet has observed, that although it is a general rule that every thing which lives respire, it is not perhaps without exceptions in insects. Many give reason to doubt of their respiration, at least in certain stages of their existence. "I took, for instance," says he, "some of those large cantharides of the willow, whose strong smell, though not very disagreeable, is felt at a considerable distance. I put them under a glass, where for a long time sulphur had been burning on a piece of copper made red-hot, that the sulphur might continue to burn in the midst of its own vapours; and although there arose so thick a smoke that it almost hid the insects from sight, they supported these vapours for more than half an hour, without suffering, that I could perceive, the smallest injury." Insects, we are aware, may live some time confined in this manner amidst the vapours of burning sulphur, but the instance adduced by Lyonet is still remarkable, for we have known the same experiment tried with these cantharides, in the result of which the insects died

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within the space of time mentioned by Lyonet; and if, instead of sulphur, we employ camphor, the respiratory powers cease, and life becomes extinguished in a shorter period.

This author argues, that from the solidity of the greater number of the cones made by the pseudo-caterpillars, and most of the ichneumon flies, it cannot be conceived possible how these insects should live several months under ground, in a place so close and impenetrable to the air, if they were to breathe in it. "Neither," says he, "would I maintain the respiration of chrysalids; at least one experiment convinces me there are some which do not breathe. I took the chrysalis of the sphinx ligustri, which being one of the largest is the most proper for experiments. It had, besides, the two anterior spiracles so open, that with a common magnifier I could see into the substance of its body, and observe a small vacuum between it and the cover. This made me hope, that if respiration took place in the chrysalis this would give me certain proofs of it. Two or three months before the perfect insect issued from its cover I dug it up, and covered several times, first one and then two, and afterwards successively, the whole of its spiracles with soap water. At each time I observed, for a considerable space, with the glass, the spiracles thus covered, to see if any bubbles of air were formed above, which would naturally have happened, had these spiracles served as conduits to the air in respiration; but with all my attention I could perceive none. Some days afterwards I repeated the same experiment, in a manner to me still more decisive. Instead of covering the spiracles with soap-water, I covered each with a little bubble of air, taken from the froth of the same water, that the air might enter and go out more freely. But my curiosity was not more gratified: these bubbles, which ought to have risen or sunk at each expiration or inspiration of the chrysalis, preserved constantly the same appearance, till their pellicle becoming dry, they burst. When the perfect insect had issued from this chrysalis, I took it up instantly, washed the inside of it, and observed at the spiracles little bundles, composed of a great number of very white threads, of which the longest were about two lines in length. These appeared to me the exuvia of the pulmonary organs. I blew on each of the spiracles with all my force, by means of a very slender tube, but my efforts could neither swell nor move any of those fragments of the vessels which were attached to them internally; but this must necessarily have happened, had the communication of the external air by these spiracles in the bronchiæ remained open, or had the insect, when inclosed in its chrysalis, been able to breathe through them. It may be inferred from this, that the chrysalis of sphinx ligustri lives for some time without respiration, and that its two anterior spiracles serve only to facilitate the evaporation of the superabundant humours, and to permit the external air to supply their place." Lyonet, however, admits, that it is not on the single experiment here related that the knowledge of the respiration in insects is founded; and that this experiment does not appear decisive. We have unequivocal proofs of the respiration of insects; a fact demonstrated beyond all doubt in numbers of the aquatic kind, and as to lungs, he says, we may assure ourselves that insects possess them without being at the trouble of dissection. The spiracles are called stigmata by the modern naturalists; stigmates of the French.

### Members.

*Legs.*—In all insects that are furnished with wings the pedes or legs amount to six, and never exceed that number; and the same is observable of the true feet in the larvæ of

those insects; the latter have spurious feet to a greater amount, but the true feet do not exceed six. The apterous tribe in this, as in other particulars, afford exceptions: those of the pediculus, pulex, lepidina, podura, and acarus genera have only six legs, and these are attached to the body in the same manner as in winged insects: the scorpio, aranea, and phalangium genera have eight; the cancer, if admitted, have as many; and in the oniscus, julus, and scolopendra, they are far more numerous, varying from ten or twelve to twenty, fifty, or even thrice that number.

The leg of an insect may be divided into four, or, more correctly, into five parts; coxa, the first joint, or haunch, at the base; femur, the thigh; tibia, the shank; tarsus, the foot; and unguis, the claw. Each of these parts is enveloped in a hard case of a horny substance, and varies in shape in different insects; the form of the feet in all the kinds being admirably adapted to their mode of life, and convenience of their motion. Some of these are distinguished by particular terms, as, cursorii, those formed for running (and which are the most numerous); saltatorii, those constructed for leaping; natatorii, those employed in swimming, &c. From the different conformations of these limbs, it is easy to recognize, even in the dead insect, the mode of life which the species is destined by nature to pursue. Those which have the legs adapted for running or walking have them long and cylindrical: the thighs of the leapers are remarkably large and thick, with the shank long and commonly arched, by which means they possess great strength and power for leaping: the legs are broad, serrated, and sharp at the edge, in those accustomed to dig in the earth; and such as are of the aquatic kind have the legs, especially the posterior pair, long, flat, and ciliated, or fringed at the edge with hair. The leapers are well exemplified in the saltatorial kinds of curculio; and the swimmers in the genera hydrophilus and dytiscus.

The coxa, or small joint at the base, connects the leg to the body, and moves in a corresponding cavity of the collar or thorax in the first pair, or breast in the two posterior ones. This part varies in form: in the cerambyx coccinella, and other tribes in which the feet serve for walking only, its shape is globular: such as require that the feet should have a lateral motion, and which is necessary to those that dig into the earth, have the coxa broad and flat; this is also observable in some of the aquatic beetles; in the dytiscus, the coxa of the posterior legs is consolidated with the trunk, and immovable; and in the blatta, lepisma, and others which walk very rapidly, it is compressed into a lamellate form.

There is more diversity in the form of the thigh than the coxa to which it is united. The articulation of these two parts is internal, and is produced in such a manner, that when the animal is in a state of repose, it is parallel to the inferior surface of the body. It is limited to a forward and backward motion, with respect to the first piece. The nature and extent of the motions of the thigh appear to determine its form. In those insects which walk much and fly little, as the carabus, cicindela, &c., the thigh has two little prominences at the base, which appear to be intended for removing the muscles from the axis of the articulation. Those which require strong muscles adapted to leaping have the thigh not only thick but greatly elongated, as in the gryllus and locusta tribes, the pulices, or fleas, &c. And in the scarabæi, scarites, and other coleoptera, and also in the mole cricket (acheta gryllotalpa), all which burrow in the earth, the thigh is moved with much force, and has an articulated surface corresponding to the flat part of the coxa on which it rests. This part is sometimes spinous.

Tibia, or shank, is the third joint of the legs, and moves in

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an angle, according to the direction of the thighs. The figure of this part depends essentially on the uses to which the habits of the insect require it to be applied; in the natorial kinds it is usually flat and ciliated, at least the tibia of the posterior pair, and in many others, as in a variety of the burrowing kinds of beetles, it is serrated. In the mantis genus, to which shanks of the anterior pair of legs serve as weapons of defence, they are broad, flat, and acute at the edge, and these they wield with dexterity in the manner of a sabre. The shank is more frequently serrated or spinous than the thighs.

The tarsus, or foot, is the fourth joint, or last portion of the leg, except the claw. This part consists in general of five joints: this is usually the number in the coleoptera, hymenoptera, and diptera; in some of these, however, and also in the hemiptera, there are only four articulations in this part of the leg, as we observe in *cerambyx*, *gryllus*, and others; in *libellula*, *forficula*, &c. three: in the anterior feet of mantis and napa only one; and in those of the nymphales family of butterflies none. The figure of the tarsus is more variable than any other portion of the leg, and is in a most singular manner adapted to the insect's mode of life. The articulations in such as walk on the surface of the earth are slender, those which burrow in the earth have them more robust. Many of those which inhabit waters have them flat and ciliated at the edges, as in the hydrophilus. Others are furnished with bristly tufts, or vascular fleshy tubercles, which enable them to move with security on smooth and slippery bodies in any direction; an admirable example of this presents itself in the common house fly, which "treads the ceiling, an inverted floor," with the same facility that other insects walk on the surface of the ground. An occasional difference in the number and form of the joints of the tarsus is sometimes observed in the two sexes of the same species. The motion of each joint of the tarsus is performed in a single plane, and is directed by two muscles in each joint, one of which is small, and placed on the dorsal surface, the other larger, and situated beneath.

Unguis, or claw, the termination of the tarsus; in the greater number of insects there are two claws attached to each tarsus: some have only one, and in others furnished with two, there is an intermediate process forming by this means three. An appearance similar to this is seen in the legs of the lucanus, but this, on minute examination, is found to be a distinct joint also, armed with a pair of claws, precisely resembling those which, more obviously from their size, appear to terminate the tarsi. It is considerably smaller, but as perfectly well defined.

Reaumur, Weifs, Borelli, and Cuvier, have published some curious remarks on the laws of motion observed in the legs of insects, some of which are very interesting. The relative proportion of the feet seems to determine, in a certain degree, the particular manner in which each insect moves either in walking or leaping. When, for example, the legs are all equal, the movement is uniform, but when short it is slow, and when long, it moves with rapidity. Those insects, therefore, which have the legs long, as in the phalangium, and some others, run very quickly: and, on the contrary, the acarus, pediculus, and those others, which have the legs short, are remarkable for the slowness of their pace. When the anterior feet are longest, as in certain *cerambyces*, their speed is retarded when moving on even ground, though, in climbing, this length of the anterior legs is an advantage. When the posterior feet are longest, they usually afford the insect the ability of leaping, as in the locust, acheta, and other families; but such a structure impedes its speed in walking; and does not always enable it to leap; the insects of the

leucopsis and chalcis genus, though their posterior thighs are very large and thick, are supposed to be incapable of this action. The latter inability is attributed to the great curvature of the legs, those insects which are truly of the saltatorial kind, as in the *gryllus* genus, being remarkably straight.

*Alæ*, or wings.—Wings, the organs appropriated to flight. These in different insects vary from two to four, and are attached to the lateral part of the breast, close to the lower margin of the thorax. They are placed to an equal amount, and in a corresponding situation on both sides of the insect, whether the number be two or four. Those insects which are furnished with only one pair of wings, have both of an uniform appearance and size. Such as have two pair most frequently differ, the first being larger than those behind: there is also a difference in shape, and very commonly a considerable variation in the spots, markings, and other particulars, notwithstanding the prevailing hues in all the wings may be the same. In general, the posterior pair is paler, and the marks obscure.

The wing properly so denominated should be distinguished from the elytra or wing-cases, those hard shelly coverings of the true wings in the alated kinds of coleoptera. These wing-cases, or sheaths, are often confounded with the wings; but they are really not wings from their structure or substance, nor do they answer the purpose of flight: they merely open to afford the true wing, concealed beneath, the power of expansion and motion, and close down upon the wing, when the insect is at rest, to preserve it from injury. Of this we have spoken more largely in describing the elytra. The semi-crustaceous wings of the hemipterous orders partake of an intermediate character between the wing-cases and wings, as already noticed in its proper section. The wings and elytra in some insects, and the wings and hemelytrous wings in others, are so intimately connected, that we conceived it requisite, in order to avoid misconception, to advert again to this circumstance.

A skeleton of nerves, more or less numerous, and differing exceedingly in disposition, placed between two thin and closely united membranes, constitute the true wing in insects. This conformation is very clearly exemplified in that description of wings which is usually termed transparent, as in the common house-fly and the bee. The true wing, by means of which the insect is enabled to fly, is always constructed in this manner, whatever may be its appearance externally, arising from a superficial covering of down, feathers, hair, or any other cause. The variety in the form and structure of the wings, in the number, figure, and disposition of the nerves, or the colours with which they are adorned, is infinite. The diversity in the disposition of the nerves is evident from a comparison of the simply constructed wing of the common house-fly (*musca domestica*) with the complex wing of the panorpa, or the ephemera, or the wing of the forficula (earwig), which consists of a series of single nerves, with the elaborately wrought lattice-work of the wing of the libellula. The whole of the lepidoptera tribe exhibit the superficial coating of feathers, down, or hairs; and upon the removal of these, the wings are found constructed exactly in the same manner as the transparent wings of the other tribes. A variation in the form of the wing, as well as its texture, is manifest throughout all the insect tribes of the winged kind. Those of the coleoptera have two membranous wings, which fold upon each other, forming a plait, or double at their external margin; which fold is accommodated by a peculiar joint in the main rib of the wing, and the peculiar disposition of the nerves in the middle of the wing contiguous. In the he-

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miptera the wings generally fold longitudinally, without any transverse double, so that in expansion these parts open somewhat like a fan: the forficula is an exception in this order, the wing in this genus being doubled across as in the coleoptera. The wings of the lepidoptera are neither doubled across nor folded longitudinally; they are entirely flat, and incapable of contraction and dilatation. In the papilio genus they are endowed with the power of erection, which is not the case in the phalæna genus, though occasionally observed among the sphinges; the phalæna have the lower wings concealed under the anterior pair, the latter being laid in a flat position over them. The wings of the lepidoptera are downy, and often decorated with very beautiful colours disposed in the most pleasing and varied manner. The neuroptera in general have the wings flat; this is not invariable: they are constantly membranaceous, and reticulated with nerves. In the hymenoptera the wings are membranaceous, generally flat, but sometimes folded, when the insect settles, as in the wasp genus. The dipterous order cannot be confounded with the preceding, as they have only two wings, without any wing-cases: they are membranaceous as in the former.

Insects of the dipterous family, bees, and various kinds of hymenoptera, and many others, possess the powers of flying in a more perfect degree than any class of animals besides; surpassing in this respect even the bird tribe. All insects that are furnished with wings have not an equal celerity of motion in the air; the movements of the wings in some insects is more circumscribed than in others. The muscles that move the wings are not yet very well ascertained: they are said to be situated in the breast, and to be of two kinds; the first of these are small and short, and are intended to extend or fold the wings, at the same time that they move them to and fro from the body; the others, which are somewhat longer, are calculated to produce these motions of elevation and depression which the wings perform, very striking examples of which are found in the two genera papilio and libellula. The wing-cases of the coleoptera are not moved, it appears, by the pectoral muscles like the wings.

The dipterous insects, when flying, emit a loud buzzing sound, occasioned, as it is believed, by the wings and balancers striking against each other. The noise of the cricket and locust is produced by the friction of the wings, or base of the wing-cases against the posterior edge of the thorax; and which is observed likewise to be the case with the cerambyx, leptura, and various other insects.

In all insects of the winged kind these organs present the greatest diversity, and afford characters both of genera and species less liable to fluctuation than common observers would conceive. The number, figure, construction, proportion, consistence, and texture of the wings have enabled naturalists to distribute insects into principal families with considerable precision; and their minor peculiarities of spots, marks, and colours, have furnished subordinate characters of the utmost utility in defining species. Linnæus derived much assistance from an attention to these parts; later writers have in many instances regarded them more closely; and in the further progress of the science, we are persuaded these parts may be consulted with much greater advantage still.

There are many terms at present in use, intended to describe the different kinds of wings, the principal of which should be understood by the student in entomology.

The wing in all insects is distinguished, with respect to its surfaces, into superior and inferior; that above is denominated the superior, and that beneath the inferior. In the

description of wings, the terms anterior, posterior, interior, and exterior parts, and sometimes the disk, occur very frequently. The anterior part or margin is that next the head; the posterior, that towards the vent; its exterior, that towards the outer edge; and the interior, that next the abdomen: the disk is the centre of the wing. These terms are not always applied with precision by entomologists: the base of the wing, next the point of connection to the breast, is sometimes called the anterior part; and in this case, every other part varies its name in a relative proportion: and this appears to be a correct method of describing the parts of a wing in its natural state, while the insect is at rest, with the wings down; but it applies only to those which dispose their wings longitudinally: it would be altogether inapplicable in describing a papilio, in which the wings are expanded and stretched forward; or in the libellula, which rests with the wings in the same position. The anterior margin of a wing is, therefore, generally understood as implying the costal edge, and which is so named because it is formed by the main rib that extends from the base to the tip of the wing.

The wings are called plicatiles, when they are folded at the time the insect is at rest; planæ, when stretched out their whole length without folds, and incapable, from the structure of their nerves, to be folded up; erectæ, such as have an erect position when the insect is at rest, the superior surfaces being brought in contact above the back, and the extremities sometimes meeting, as in the butterfly tribe; patentæ, those like the geometra family of moths, and most of the libellula, which have the wings expanded horizontally when at rest; incumbentes, such as cover in an horizontal manner the superior part of the abdomen, when the insect is at rest. These differ from deflexæ, in having the outer edges declining towards the sides, like the ridge of a house; reversæ are also deflexæ, with this addition, that the edge of the inferior wings projects from under the anterior part of the superior ones; dentatæ are those with the wings indented or scolloped; caudatæ, those in which one or more of the nerves of the posterior wings extends beyond the margin, and forms a process, such as occurs in the equites family of papilio, and the genus hesperia, and in a far more remarkable manner in phalæna argus; reticulatæ, those in which the veins or membranes of the wing form a kind of lattice-work, as in the genus libellula.

The colours (colores) are named in terms agreeably to their common acceptation; but according to the various forms of the spots, bands, streaks, &c. in which they appear on the wings, they have various significant appellations. Maculæ are spots; punctæ, dots; fasciæ, bands; strigæ, streaks; and lineæ, lines. Ocellus is a round spot, containing a smaller spot of a different colour in its centre. Stigmata is a term in the Linnæan language, introduced to signify a spot or anastomosis in the middle of the wing, near the anterior margin: this is conspicuous in most of the hymenoptera and neuroptera. Stigmata is a term also applied to the single or double kidney-shaped spot situated in the middle of the anterior wings in many of the moth tribe, in the noctua family, and in some of the bombyces. Several modern naturalists call the respiratory spiracles at the sides of the body in insects stigmata, the application of which may create confusion; stigmata, and stigma, ought for this reason to be admitted in the sense Linnæus intended: the spiracles bear already a name sufficiently indicative of their use and appearance, and do not require this alteration. Most of these terms apply only to the lepidoptera tribe, in the markings of whose wings the most beautiful colouring prevails.

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*Halteres*, poisers, or balancers, appendages peculiar to insects of the diptera order, and which, with sufficient reason, are deemed an essential character of that tribe. These poisers are two short, moveable, clavated filaments, placed one contiguous to the origin of each wing. They seldom exceed one-tenth the length of the wing, though in certain genera they are rather longer. The capital, or head, in which the filament terminates is either roundish, oval, truncated at the end, or compressed at the sides: in some insects its situation is directly under a small, arched, filmy scale, which also varies in size and form; and in several families is entirely wanting.

The exact purpose to which nature has destined these organs has not been hitherto ascertained in a very satisfactory manner. The most prevalent, and perhaps in some measure the most consistent, opinion seems to be, that they balance or counterpoise with the action of the wings, when the insect is in flight, in the same manner as rope-dancers exercise a pole to preserve their equilibrium. The diminutiveness of their size is a plausible objection to this idea. Others consider these as the organs of that vibratory sound which dipterous insects emit in flight: they compare the filmy scale to a kind of tambour, and liken the balancer to a drum-stick, which striking repeatedly upon it, they conceive must occasion this noise. In the conformation of the drum-like organs under the breast of some species of tetti-goniæ, this conception is fully realized; a sound is actually occasioned by similar means. (Vide *Donov. Inf. China.*) But with regard to the diptera, it is apprehended the sounds they emit in flight cannot be traced to this cause: in some we know it cannot, for the best of all possible reasons, namely, that though, like others of the same tribe, they have balancers, they have no scale to strike with them. It should be observed also, that this buzzing sound is observable in a vast number of insects which have no poisers or balancers, such as wasps and bees. The two genera, *asilus* and *bombylius*, have no scale, and yet the noise perceptible in their flight is louder than in most of those which have both scale and poisers, as in the *muscæ*, for example. Nor does this noise issue from the poiser, either by striking on the scale, or by any other means, as must be admitted, since it is known that if the poisers, or both poisers and scales, be cut off, the same sound continues to be heard from the mutilated insects as before.

The motion of these poisers, when the insect flies, is very lively: they are longest in the *tipula*, *diopsis*, and *asilus*; in *musca*, scarcely apparent, and accompanied by a scale of large size.

*Elytra*, or wing-cases, appertain to the coleopterous tribe: these are two in number, of a substance resembling leather, for the most part moveable, and opening by a longitudinal suture along the middle of the back. The *elytra* are extended or raised up when the insect is in flight. They do not appear to assist the insect in its flight; the muscles, by which they are connected to the body, have not their seat in the breast, like those of the true wings; and its movement in the air is accomplished by means of the latter, which are transparent, folded between the body and *elytra* when at rest, and expanded when the insect flies. Some have the *elytra* united, and may with more propriety be named *elytron*, for it consists only of a single piece marked with a longitudinal line superficially, instead of being divided by a suture; this is lifted up, or rather, the abdomen depressed downwards, to admit the passage of the wings laterally, when the insect is preparing for flight. Others furnished with *elytra*, or wing-cases, seem to render the term for these parts exceptionable; for in reality they have no

wings beneath them: the number of these, however, is not considerable, and they cannot employ their *elytra* as organs of flight.

The superior surface of the wing-cases is more or less convex, and the lower surface correspondently concave: the texture in some, as in some of the *curculio* and *buprestis*, so hard, that it is pierced with difficulty by means of a strong pin; in others so flexible, that they spring into their proper form immediately after being bent double. The proportions of the *elytra*, compared with the body, are various, their form dissimilar, and the diversity of their surface, arising from dots raised or depressed, protuberances, flutings, colours, and other circumstances, endless. These differences in the *elytra* furnish some excellent generical distinctions, and are still more extensively useful in constituting the characters of species. When the wing-cases are shorter than the abdomen they are termed *abbreviata*, unless they terminate in a transverse line, when they are called *truncata*; *fastigiata*, when of equal or greater length than the abdomen, and terminating in a transverse line; and *ferrata*, when the exterior margin towards the apex is notched or serrated, as in some of the *buprestis* genus. The appearance of the surface is variously distinguished; *spinosa* is the term implying that the surface is covered with sharp points or spines; *scabra*, rough; *friata*, marked with slender furrows longitudinally; *porcata*, with elevated longitudinal ridges; *fulcata*, with concave ridges, &c.

The want of appropriate terms for those kinds of wing-covers, which partake of a middle texture between the *elytra* and the wings; and also for those in which the characters of both are united, must be obvious in the present state of entomology. To the first of these no suitable name has been given: the French "*ètius molle*," and "*ètius presque membranaceux*," are not sufficiently expressive; the first is deficient in precision, and in the other there is too much latitude. Linnæus once proposed the term *hemelytra*, by which he intended to designate both kinds, whether, as in the *grylli*, those parts were of an intermediate substance between leather and membrane; or, as in *cimices* and *nepæ*, one half was coriaceous, and the remainder membranaceous. The term, in this general sense, could not be strictly proper; it was, notwithstanding, preferable to that of *elytra*, admitting the latter to be rightly applied to the wing-cases of the *coleoptera*; and we are therefore the more surprised it was not afterwards adopted by that naturalist, or some other substituted. So lately as the tenth edition of the *Linnæan Systema*, the word *elytra* is employed indiscriminately for the hard and stubborn wing-cases of beetles, the soft wing-covers of the *blatta*, and the membranaceous reticulated wing-covers of the *gryllus*, all which genera were included at that time in *coleoptera*; and by an oversight equally extraordinary, the half-coriaceous wing-covers of the *cimices*, the *nepæ*, and *notonectæ*, were then confounded with the delicate covers of the *aphis*, *thrips*, and *chermès*, under the indiscriminate title of wings. The distinction of *coleoptera* and *hemiptera* is rendered rather more clear in the last edition of that work, the *blatta* and *grylli* being removed from the former to the latter order; yet the application of the word *elytra* to the wing-cases of the *hemiptera* is not by that means rendered less improper. The difference in the conformation and consistence of the wing-covers in the two tribes is too evident to leave this a matter of doubt. But custom has so far sanctioned this impropriety, that our best entomologists to this period describe all these kinds of wing-covers under the name of *elytra*. Fabricius has not even attempted to correct this error in the *Linnæan phraseology*: he adopts the same term.

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Among the principal differences in the form and texture of the elytra, some, at least, are very remarkable. In the beetle, or coleoptera tribes, these parts are coriaceous, very hard throughout, convex in form, and divided by a straight suture. Those of the cimex genus have the upper half only of a coriaceous texture, the lower half being soft and membranaceous, and the latter portion of one elytron is folded across the corresponding part of the other when the insect is at rest. The coriaceous half of the elytra in many species is as hard and tough in texture as the entire elytra in the coleoptera, and the membranaceous part as soft as in the hymenoptera and diptera. In the genera blatta, forficula, acheta, and others, the elytra is of an uniform substance throughout, somewhat resembling parchment; a similar texture prevails in the elytra of nepa, notonecta, and naucoris genera, but rather like the cimices, there is a distinction between the upper and lower portions, the first being of a firmer texture, and thicker than the other part. The fulgora genus, like the gryllus, affords examples of another kind, thick, membranaceous, and strongly reticulated elytra, divided in the middle by a longitudinal suture. In the tettigonia, another of the hemipterous genera, the elytra are often perfectly membranaceous and transparent in texture, though not in form resembling those of the hymenoptera and diptera; yet these are called elytra, and so likewise are the weaker and more flexible transparent anterior wings of the aphid, thrips, and chermes, for these two are included in the order hemiptera! From a due consideration of these decided differences, we cannot hesitate to admit that the term elytra is not applicable to all. In a treatise of this kind it might, perhaps, create confusion to introduce any other terms than those in common use; we only intimate our persuasion, that reformation in the language of entomology is necessary. In the formation of any new system, and which in the present state of science appears requisite, we may reasonably hope to see these and similar objections obviated.

In conclusion of these remarks, it may be mentioned that nature has herself pointed out certain discriminating characters in those parts called the elytra which do not seem to have been sufficiently attended to, and which not only relate to their figure and appearance, but likewise to their utility, or the benefit the insects derive from these organs. The wing-covers in the coleoptera do not, it is generally believed, in the least degree, assist the insect in flying; in the cimices, and others which have those parts of a more flexible texture, they do not materially aid its celerity of motion in the air; but in those which have the wing-covers completely supple, they concur immediately to its velocity in flight.

### *Sexes of Insects.*

The same difference of sex exists throughout the insect race as in most other animals. The sexes cannot be ascertained in the larva and pupa state, except in some few instances; but when they arrive at their last state, both kinds possess permanent characters, by which they may be easily determined: these consist in a comparative difference in their size, and vivacity of colour, form of the wings, bulk of the abdomen, shape and dimension of the antennæ, and various other external peculiarities.

In most insects the male is smaller than the female, their comparative difference varies considerably in different species. In the lepidopterous tribe the female is only perceptibly larger than the other sex in general; in the ant it is six times larger than the male: in the coccus twelve or fifteen times, and in the termites the female is at least two hundred times larger than the male. This latter sex is commonly

decorated with colours more lively and brilliant than the females, a distinction observable in a very remarkable degree in many of the butterfly tribe, the males of which are very beautiful, and the females obscure. There is also some difference in colour between the two sexes in some coleopterous insects.

Many of the larger tribes of beetles (geotrupes) present a wide dissimilarity in the conformation of the two sexes: in the males the head is embellished with one, two, or more distinct and prominent horns, and which, in a number of species, are very considerable in size: these are entirely peculiar to the males; the head of the female has only a few slight protuberances instead of horns, and is sometimes even destitute of them.

In the moth tribe the antennæ of the male are almost invariably larger or more deeply pectinated than in the female, and this difference may be traced from the broad feather antennæ of the largest bombyces, to the setaceous antennæ of the noctuæ; however slightly the antennæ of the male appear pectinated, those of the female will be found still less so. The abdomen in this order is also smaller than that of the female. The colours of the wings also differ amazingly in the two sexes, of which phalæna humuli (Linn.) affords a very striking example, the wings of the male being of a beautiful snowy white; that of the female bright yellowish, with orange spots.

Another distinction, but which is not a general character, consists in the female being apterous, or without wings, the male being furnished with those organs of flight. Among the coleoptera we find the lampyrus of this kind; in the hemiptera the blatta; among the moth tribe, phalæna antiqua, gonostigma, brumata, &c. These wingless females are indeed so much unlike the other sex, that no one unacquainted with insects could believe them to be of the same species. The females of these lepidopterous insects are not entirely apterous; they have four very minute wings attached to the thorax, in the same place as is occupied by the base of the wings in the other sex, otherwise they resemble an apterous insect. In the aphid tribe the male has sometimes wings, and is sometimes without; and the female, it is said, differs in the same manner.

These are the principal external characters, by means of which the two sexes in insects may be discriminated.

### *Generation.*

That general law of nature which prevails among the larger tribes of animated beings, and ordains an intercourse of the two sexes as indispensable to the production of their young, does not regulate the multiplication of all insects: there are some singular deviations to the contrary. The doctrine held by the ancient sages of Egypt, that in certain insects both sexes are united, is perhaps inadmissible: we ought not to speak with too much confidence on this subject, notwithstanding the assurance of Linnæus, that there are no hermaphrodite insects. The observations of naturalists leave us in no uncertainty with respect to another order of beings, namely, those which belong to neither sex; and indeed the existence of these is demonstrated daily in every hive of bees.

The mysteries of generation are only in part unveiled to the philosophical enquirer. Some leading points appear equivocal, and remain inexplicable. This is the case with larger animals, where we have external circumstances to direct our judgment. With respect to insects, in particular, the history of their generation, in certain instances, at least, is more obscure. Many of them, like the larger animals, produce their young in consequence of an immediate union.

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of the sexes. But among the numerous families which compose this extensive class of creatures, there are some deviations from this ordinary course of nature, and these partaking of incidents so remarkable, that no positive and uniform conclusion of their mode of increase can be laid down. The notions entertained by some philosophers in the middle ages, that insects are the offspring of corruption and putridity, have no foundation in reason or analogy. It is impossible to conceive that organized bodies, possessed of life, and endowed with sensibility, can owe their origin to chance. But beyond this we are authorized in the belief of circumstances, that militate very strongly against established opinions. The course of generation and mode of increase, observed in certain tribes of insects, have no parallel among those of the larger kinds of animated beings: we need only mention a few particulars of the aphides in support of this.

Of the aphid genus there are not less than seventy species known, and the females of every one of these, so far as it has been possible to investigate their manners, are capable of producing their young without the concurrence of the male sex! A female aphid, brought up in the most perfect seclusion from the very instant of its production from the egg, will in the course of a few days be found in the midst of a numerous family of females only, brought forth alive. An individual taken from these, or even selected at the moment of its birth from the brood, and kept alone, will in a short time produce another brood, and in like manner a repetition of the same experiment will be again attended with the same results.

It would be only a natural inference drawn from the above mentioned circumstances, that in the same individual of this kind the two sexes must be united. This we know is not without example in the inferior order of animals, the greater part (we shall not say the whole) of the vermes tribe being probably of this description. Such is not apparently the case however with regard to the aphid; the real truth appears still more astonishing. To render these fertile, the intervention of the male seems to be requisite in autumn, and hence the power of impregnation devolves down to the tenth, or, as some naturalists affirm, to the twenty-seventh generation. The eggs of the first, or parent brood, are laid in autumn, these hatch in the ensuing spring, and this fertile produce perpetuate the race through many generations till the autumn following; every brood, after those hatched in spring from the egg, being viviparous.

The generality of vermes are believed to unite the two sexes in the same individual, and thus possess the power of self-production. Later observations seem to prove, that most animals of this tribe have both male and female organs, but that the union of two individuals are still requisite, each performing at the same time the office of male and female, and by this reciprocity of their functions both become fertile. Among the cancri, which Linnæus considers of the insect race, we are assured some monstrous lusi have been observed, in which the organs of both sexes were apparent; but probably these might not possess the ability to perpetuate their natural race. These we pass over therefore for the present as irrelevant. There is no insect, perhaps, such accidents excepted, in which the two sexes are united. We advance even this with caution, because there is reason to imagine the contrary in certain instances. From our own observation we are persuaded that some few at least of the supposed vermes are the larvæ of genuine insects. Let us for a moment imagine these larvæ to be really vermes! And let us farther conceive that these larvæ, like the true vermes, are

of the hermaphrodite kind! What an extraordinary deviation from the usual course of nature would such a prodigy present!

Here, however, be it explicitly understood, that we do not assert the latter part of this observation as absolutely certain. Such an assertion is countenanced by no opinion except our own, and such opinion ought not to be advanced without being at the same time supported by argument and proof, the production of which would extend the limits of our observations very far beyond our present design. It is only our wish to intimate at this time, that there are certain animals of the supposed vermes, and which are described by Linnæus and others as appertaining to this class, which are in reality the larvæ of insects; and that we are not without suspicion that some of these larvæ are fertile, and produce an increase in a manner not very clearly known, before they assume their final form. Among the supposed vermes of the marine kind, the larvæ of certain coleopteræ will perhaps be recognized. These are simply larvæ, and apparently destitute of any sexual functions till they arrive at their last state. Some of the fresh water larvæ, mistaken for vermes, are in all probability of the same description. But have we sufficiently examined the intestinal vermes? Are any of those peculiar to different animals, or man, capable of producing young vermes, like themselves, and afterwards becoming insects? One fact may be important, and we state it upon the testimony of our own knowledge, that certain kinds of these supposed vermes, which infest the human race to the destruction of thousands in the age of infancy, are really no other than the larvæ of insects.

Linnæus affirms that no insect can form an union with the opposite sex, or propagate its kind till it arrives at the last state, and offers this as a proof that gryllus pedestris is not a pupa which its appearance implies, because it is found connected with the female. This observation of Linnæus is pretty generally correct, and it may be further added, that in the different states, prior to the perfect condition, there are no sexual organs, or at least none that are developed. This is the fact with regard to most insects, certainly not to all. Among the cimices there can be no doubt in our own mind from actual observation, that the semi-nymphs of certain species do unite with their mates, and afterwards become winged insects. We are not without suspicion that many of the grylli, like the pedestris, possess the same faculty, and are afterwards furnished with wings.

With respect to the insects of neither sex, or neuters, it should be observed that those appertain to species in which there are the two distinct sexes besides, as in the bee tribe. It is chiefly among the hymenopterous insects that we meet with these neuters; the formicæ afford examples of other insects of the same kind, and it is believed there are likewise neuters among the coleoptera. They are called neuters because they are of no apparent sex. Some have pretended that they are no other than females, in which the sexual parts are not yet developed. This cannot, however, be the fact; neither can they be of the male sex under the same disguise, because they are constantly dissimilar in their characters from both, and could scarcely be supposed, from their appearance in many instances, to belong to the same species they really do, had not this been ascertained by their production from the same brood with the two distinct sexes.

Of insects in general it may be observed, that the males and females of the same species are not unerringly faithful; they deviate occasionally from the path appointed by nature. This is most observable in the coccinella genus. These hybrid insects are conceived to be unfruitful; they resemble

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the female in form, but in point of colours and spots have some resemblance to the male parent.

There is an accordance in the structure and situation of the sexual organs in insects, whether male or female, with those of larger animals, and their union is accomplished in the same manner. These organs are usually placed at the extremity of the abdomen. This is not constantly the case; there are insects, and among those the spiders, which have the male organs placed at the tip of the feelers, one at the extremity of each; every individual of these creatures being furnished with two. The female organ is beneath the abdomen. Another singularity is observable in the libellule (dragon fly), the males of which have the sexual organ situated under the breast, while that of the female is at the extremity of the abdomen. When in union they are seen flying in the air, the female under the male with her slender body incurvated, and the tip of the abdomen bent under his breast.

Except at the period of their amours the sexual organs of insects are not perceptible, those of the male at other times are drawn within the body. Their union in some species continues for a short time only; others remain in this state for hours, or even days together.

*Transformation of Insects.*

Most animals retain during life the form which they receive at their birth. Insects are distinguished from these by the wonderful changes they undergo. The existence of an insect partakes of two, three, or four distinct states, and in each of these differs most essentially in appearance, organization, and manners of living.

The ancients were not unacquainted with the singular metamorphoses of insects. Ovid has drawn many beautiful fables from this source. The songs of Anacreon afford certain passages to the same effect; and we might also mention others. An inquiry into the knowledge of the ancients in this respect might be interesting; but we cannot now pursue the investigation, as it would lead to digressions the limits of this article will not allow. Our ideas have been offered at some length in another place. (Donov. Hist. Inf. China.) We shall only observe for the present, that they were not unacquainted with the metamorphoses which certain insects undergo. Their poets wantonly intermingled fable with truth, to improve their allegories; but their historians were more correct, and seldom formed erroneous conclusions, unless deceived by specious appearances. In the sixteenth century, with the revival of learning and philosophical discussion, and from that period to the present, this subject has engrossed much attention. The labours of Swammerdam, Goedart, Merian, Malpighi, and others, contributed materially to its advancement in the first instance. Their discoveries induced others to regard the transformations of these curious creatures with attention; and hence, in the course of years, their history became pretty generally understood. Those who afterwards contributed most essentially to the improvement of this branch of entomological knowledge were Reaumur and Degeer. In the progress of time, other valuable works appeared in elucidation of the same subject. The most useful of these, perhaps, to the general reader, are those denominated "Entomologi Topographici," or such as relate to the insects, with their transformations peculiar to, or inhabitants of particular countries. Among the number of these may be mentioned the two works of Merian, "Erucarum ortus, Alimentum et Paradoxa Metamorphosis," and "Insecta Surinamensia." "Histoire abrégée des Insectes, qui se trouvent aux En-

virons de Paris," by Geoffroy; "Nauwkeurige Waerneemingen," &c. of Adniral; Roefel's "Insecten Belustiging;" Abbot's "North American Insects," by Smith; and Donovan's "Insects of Great Britain."

The changes through which the greater number of insects pass are from the egg to the larva, from the larva to the pupa, and from the pupa to the last or perfect state. Exceptions occur to this: for some insects are viviparous; the number of these is not considerable: and there are others of the apterous or wingless kind, which undergo no change, issuing from the egg in the perfect form.

*Of the Egg State.*

The egg, containing the insect in its smallest size, is expelled from the ovary as in oviparous animals. They are contained and arranged in the body of the insect, in vessels which vary in number and figure, in different species. The same variety is found in the eggs: some are round, others oval, some cylindrical, and others nearly square. The shells of some are hard and smooth, while others are soft and flexible. It is a general matter of observation, that eggs do not increase in size after they are laid: among insects we find, however, one exception to this rule, for the eggs of a species of tenthredo are known to become larger after being deposited. The shell is membranaceous, which admits of this dilatation.

The eggs of insects are of various colours; some are found of almost every shade of yellow, green, and brown, a few are red, and others black. Green and greenish are not unusual, and they are sometimes speckled with darker colours, like those of birds. Some are smooth, and others beset in a pleasing manner with little raised dots.

Insects are instructed by nature to deposit their eggs in situations where their young ones will find the nourishment most convenient for them. Some deposit their eggs in the oak-leaf, producing there the red gall; others chuse the leaf of the poplar, which swells into a red bladder: to a similar cause we are indebted for the knob, which is often seen on the willow leaf, and the three-pointed protuberances upon the termination of the juniper branches. The leaves of the veronica and cerastium are drawn into a globular head, by the eggs of an insect lodged in them. The phalæna neutria glues its eggs with great symmetry in rings round the smaller twigs of trees; others affix them to the surface of leaves; and again, others lodge them in the crevices of trees.

The gnat, the ephemera, phryganea, and libellula, hover over the water all day to drop their eggs: these hatch in the water, and continue there while in the larva and pupa form, quitting the water only when they attain the winged state. The mass formed by the eggs of the gnat resembles a little vessel, and floats on the surface. This insect deposits only one egg at a time; the first is retained by means of the legs, when dropped, till a second is deposited next to it, then a third, fourth, and further number, till the mass becomes capable, from its symmetry, to support itself upright. Many moths cover their eggs with a thick bed of hair or down, collected from their own body; others cover them with a glutinous substance, which, when hard, protects them from the ill effects of moisture, rain, and cold. The solitary bees and wasps prepare nests in the earth, hollow trees, or cavities in old walls, wherein they place a quantity of food for the support of the young brood, when they break from the egg. Some of the spiders carry the eggs on their back in a small silky bag. The ants are known to construct nests in the earth, in which their eggs are placed

placed with the utmost care. Some deposit their eggs in the larvæ of other insects, chiefly those of the moth and butterfly kind; and having passed through all their changes in their bodies, become what is termed the ichneumon fly. In the Lapland Alps there is an insect called the rein-deer gad-fly (*oes-trus tarandi*), the attacks of which are greatly dreaded by the rein-deer. It hovers all day over these animals, who betray every mark of fear; their legs tremble under them; they prick up their ears, and rush to the mountains covered with ice and snow, to escape from the fly, but often in vain; for the insect follows, and generally finds means to lodge its egg in the back of the deer. The worm hatching penetrates the skin, and remains under it in security during the winter; in the year following it falls out, changed to a pupa, and becomes a winged insect. The *oes-trus bovis* is an equal terror to oxen; the *hippobosca equina* to horses; and *oes-trus ovis* to sheep: the latter in-finuates its eggs into the head of those useful animals, through the nasal organs.

The nest formed by the female of *hydrophilus piceus*, for the preservation of their eggs, is altogether remarkable, and is described with much minuteness by Lyonet. This nest is whitish, its figure an oblate-spheroid, three-fourths of an inch in length, and its breadth two-thirds of its length; on the upper surface it is terminated by a lengthened horn-like process, an inch long, ending in a point, and of a brownish colour. In this nest the eggs are deposited, and left floating on the water till in due time they hatch, and the larvæ desert the little bark contrived for their preservation in the state preceding, committing themselves to the water. These coques generally float among reeds and duck-weed. The purpose of the conical projection is supposed to be that of sustaining the case in an upright position, when assailed by the wind: but this is mere conjecture; we may have yet to learn its actual destination. Another aquatic insect, (one of the *nepa* genus,) that inhabits the waters of China, exhibits a far more extraordinary instance of the parental care which the insect race evince for the preservation of their eggs. This diminutive creature, scarcely an inch long, and of a subrotund figure, with the upper and lower surfaces flattened, is seen at particular seasons bearing a large cluster of eggs on its back, which, though disposed as compactly as possible, by being placed on one end, and having the sides touching each other, cover no inconsiderable portion of the whole surface of the disk. In this manner they are conveyed by the insect, wherever it goes, till the larvæ hatch, and drop instinctively into the water; when the parent insect casts off the exuvia of the nidus, and resumes its former appearance. (Donov. *Inf. China*.)

Of all the productions of nature insects are supposed to be the most numerous and fertile. With the exception of fishes and crustacea, they are apparently the most prolific. Lyonet has offered a curious estimate of the increase of insects, taken from their eggs. From a brood of 350 eggs, which he obtained from a single moth, he selected 80. These, when arrived at their perfect state, produced 15 females; and hence he deduces the following conclusion. If 80 eggs give 15 females, the whole breed of 250 would have produced 65. These 65, if equally fertile, would have produced 22,750 caterpillars, among which there would have been 4265 females. These, in the third generation, by the same mode of calculation, must amount to 1,492,750 caterpillars. The number would have been still greater, if in the first instances a larger number of females had been selected.

*Of the Larva State.*

*Coleoptera*.—The larva of all the coleopterous tribes of insects is produced from an egg, in which the growth of the creature in an embryo or infant state may be easily traced some time previously to its birth. They are either of a heavy, slothful, and voracious disposition, as may be observed most commonly of those which pass their lives under ground, in putrescent substances, or the trunks of trees; or brisk and active, like the generality of those in the succeeding or hemipterous order. Among the coleopterous larvæ of lively manners we must rank some of the terrestrial kinds, which, though they live in the earth, are always found close to the surface, and affect particular soils; and those of sands, in maritime situations especially: to these we should add the inhabitants of the watery element, or those which, in the state of larva, are of the aquatic kind; and in short, all that are carnivorous: these being more remarkable for their activity than such as are destined by nature to feed on plants only. A succinct account of the larvæ belonging to a few of the principal genera, and a concise description of their manners, will be sufficient to afford an accurate idea of the modes of life pursued by the larvæ of coleopterous insects in general.

We know nothing from actual observation of the larvæ, from which the larger kinds of extra European beetles are produced: the transformations of the species *hercules*, *al-cides*, *actæon*, *atlas*, and *goliathus*, and a host of other gigantic animals of the same kind, (the largest of the insect race,) remain at present in obscurity. Yet we are at no loss to conceive what the appearance of such insects in the larva state must really be, so far as we already know their affinities; because, from analogy, we can conclude they must be similar, or at least, generally speaking, we may presume with safety they differ only in some slight degree. The transformations of the species *nasicornis*, a native of Europe, an insect of large size, and from its conformation possessing habits similar to some natural family of exotic beetles, will, for example, assist our conclusions as to those resembling it; and, in like manner, the transformations of other extra European kinds may be determined with some precision, from the known changes of those insects naturally allied to it, or, in other words, of the same natural family.

*Scarabæus nasicornis*, or, as it is sometimes called, the rhinoceros beetle, from the conspicuous horn placed erect on the head of the male, resembles an extensive family of *scarabæi*, the inhabitants of Asia and Africa. The larva is hatched from an egg of a roundish form. The body is like that of a thick and somewhat broadish annulated worm, of a pale yellowish-white colour, flattish on the belly, and with the skin much wrinkled. The lateral breathing spiracles are very distinct, the head is hard and scaly, and armed with powerful jaws; and the three anterior rings of the body are furnished each with a pair of scaly jointed feet. It is found in the earth and in hollow trees, and several times casts its skin before it changes into the pupa state. The larva of the cock chafer, another of the *scarabæi*, (*melolontha*, Fabr.) resembles this, except in being smaller: like the rest of its family it spends the greater part of the time, while it remains in the larva form, in the earth, where it subsists on the roots of plants. It is two, and sometimes three years in passing from the egg to the perfect state.

The stag beetles, (*lucanus*;) in the larva state, bear a strong similarity with the preceding; they reside chiefly in rotten wood. The larvæ of some *cerambyces* resemble these in being soft, and in having the head and feet scaly. It is

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the larva of an insect of this genus (*C. damicornis*) which is eaten, and considered as a delicacy in the West Indies. The species is a native of this and other parts of America, and it is credibly affirmed, on the best authority, that some people of fortune in the West Indies keep negroes for the sole purpose of going into the woods in quest of them, and scooping them out of the trees. Their general length is about three inches and a half, and their thickness that of the little finger. Dr. Browne, in his history of Jamaica, particularly describes this insect; he informs us it is chiefly found on the plumb and silk cotton trees; that they are commonly called macacos, or macokkos; and that the mode of dressing them, after opening and washing, is to broil them carefully over a charcoal fire. The epicures of these trans-Atlantic regions only imitate the epicures of antiquity: they also esteemed the larvæ of the beetle tribe as a delicacy, and introduced them to their tables.

Many species of that elegant tribe of beetles, the curculiones, are the offspring of larvæ, bearing some resemblance to the former: their body is covered with a wrinkled skin, their head with a scaly covering, and the three anterior rings of the body furnished each with a pair of feet. These infest plants of various kinds; some subsisting on the flowers, others the leaves, the roots, seeds, &c. One of these, the larva of *curculio palmarum*, deserves notice for the same reason as that of *cerambyx damicornis*. This larva is about two inches long, and of an oval shape. It lives in vast numbers in the middle of the trunk of the young palm trees, and feeds on its juices. These trees are sometimes cut down, when about the height of a man, and the tenderest part of them eaten; the worms are also taken care of, being considered as highly agreeable food when roasted.

The larvæ of the coccinellæ have the body long, annulated, and furnished with six feet; they run briskly over plants, and feed chiefly on plant lice. The larvæ of the genus *cassida* are generally found under the leaves of plants on which they feed, to which they adhere by means of their lateral spines, and a bristle at the end of their tail. They form a kind of umbrella with their excrement, under which they are sheltered from the sun and rain. The larvæ of the cicindelæ are soft and white, long six-footed, and have a brown scaly head. These creatures employ great address to entrap their prey: like the lion ant, in some degree, the larva lurks in a round perpendicular hole in the ground, with its head at the entrance, to draw in and devour whatever insects come within reach. The larvæ of dermestes live in leather, fur, and other similar substances, to which they do considerable mischief. The larva of the *ptini* insinuates itself into wood, and destroys it.

That similarity in exterior characters, which we observe so prevalent in the perfect state of all coleopterous insects, whether of the terrestrial or aquatic kinds, is not apparent in the larvæ of those two natural tribes: they are in this state altogether remote, and have no greater analogy in their conformation than in their manners of life, or the elements in which they exist.

The larvæ of the dytisci constitute a link of beings closely allied to some of the neuroptera; and this resemblance is so remarkable, that certain species of dytisci and hydrophili in that state differ more from each other than they disagree with the larvæ of the libellula; these latter presenting creatures of an intermediate character, and which, to an ordinary observer, would seem to unite them. Thus, the larva of *libellula grandis* more closely corresponds with those of *dytiscus marginalis* or *punctulatus*, than the latter with *dytiscus caraboides*; and in external aspect the affinity of the

larva of *dytiscus caraboides* may be even stronger towards that of *ephemera marginata* or *hemerobius lutarius*, than to either of the former. There is certainly a difference between these in the structure of the jaws, &c.; but we speak only of those obvious characters and general appearances which first excite attention.

*Dytiscus marginalis*, the species before mentioned, is common in many stagnant waters; and, from resembling the shrimp in some distant degree, bears the name of *squilla aquatica* in the writings of Mouffet and Aldrovandus. It measures, when full grown, about two inches and a half in length, and is of a pale yellowish-brown colour, and very transparent. The head is large, somewhat flattened, and furnished in front with a pair of very strong curved forceps, which, when magnified, are found to be perforated at the tip: these are the instruments with which it seizes upon its prey, and sucks its animal juices. The legs are slender and small in proportion to the body; the tail terminates in a trifurcated process, ciliated at the margin. This larva is a fierce destructive creature, and not only commits vast depredations among the weaker kinds of water insects, but preys also on the fry of fishes, and is for this reason highly injurious in fish-ponds. It is supposed, like some others of the same genus, to remain two years in the state of larva. *Dytiscus cinereus* is produced from a larva somewhat similar, but remarkable for the length of the legs: its habits are the same. *Caraboides* is an hydrophilus, having the antennæ clavated instead of filiform; the body of the larva is shaped like the former, but on each side is a single series of plumose branchiæ, or breathing organs, like those observable in the larvæ of *ephemera marginata*. In the first stages of growth this larva is fuscous; when full grown, the posterior part is greyish and rather pellucid. The gyrius is another aquatic genus, and, from its form in the perfect state resembling the dytisci, has been supposed similar in that of larva; an argument, as already shewn, not always admissible. From the representations given by some authors, it is not unlike that of *H. caraboides*, in the species natator, only of a more elongated form, and having four ciliated appendages at the posterior end.

*Hemiptera*.—The larvæ of all hemipterous at present known are furnished with six legs, antennæ, and organs of the mouth, as in the perfect insect from which they originate; and agree with them in most other respects, except in being entirely destitute of wings. The larvæ of the mantes are carnivorous; those of the grylli feed on plants and farinaceous matter; the nepæ are aquatic, and subsist on water insects; the cimices, inhabitants of the land, and a most extensive tribe, are entirely carnivorous, and like that odious and well-known insect of the same genus, (the common bug,) derive their sustenance from the blood and juices, extracted by means of their proboscis, from the bodies of other animals, those of the largest kinds, and man. not excepted.

*Lepidoptera*.—The caterpillars of the butterfly, sphinx, and moth tribes form a very numerous series; and these, from a variety of concurrent circumstances, have been more particularly observed than any others. The greater part of those lepidopterous insects which come forth in the spring or summer perish or disappear at the approach of winter. There are few, the period of whose life exceeds that of a year. Some survive the rigours of winter from being concealed under ground, and others remain hid in the bark of trees, or in the chinks of old walls, but the proportion of those which out-live the inclemency of the winter season is very inconsiderable, unless it be those in the egg state. Those which

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which are hatched in the autumn, and live under ground or in other places of security during winter, usually come forth in the spring, take proper nourishment, and undergo their several changes to the perfect state. The eggs, which have been carefully deposited by the parent fly in those places where they could remain in the greatest safety, are also hatched in general by the genial influence of the spring, and the infant brood called into life and action.

All caterpillars are hatched from the egg, and when they first proceed from it are generally small and feeble, but grow in strength as they increase in size. The body of the caterpillar consists of twelve rings; the head is connected with the first, and is hard and crustaceous. No caterpillar of the moth or butterfly has less than eight, or more than sixteen; those which have more than sixteen belong to some other order of insects. The six anterior feet, or those next the head, are hard and scaly, pointed and fixed to the first three rings of the body, and are in number and texture the same in all lepidopterous larvæ. The posterior feet are soft, flexible, or membranaceous; they vary both in figure and number, and are observable only in the caterpillar state, the perfect insect having only six feet, the rudiments of which are the six anterior scaly feet before-mentioned. These spurious feet are either smooth or hairy, soft to the touch, or hard, like shagreen. On each side of the body are nine small oval apertures, which are considered as the organs of respiration, and are called spiracles. The head is covered with a shelly substance, and on each side are five or six small black spots, which are supposed to be the eyes. Some caterpillars grow to a very large size.

The caterpillar, whose life is one continued succession of changes, often moults its skin before it attains its full growth. These are the more singular, because when it moults it is not simply the skin that is changed; for we find in the exuvia the skull, jaws, and all the exterior parts, both scaly and membranaceous, which compose its upper and under lip; its antennæ, palpi, and even those crustaceous pieces within the head, which serve as a fixed basis to a number of muscles; we also find in the exuvia the spiracles, the claws, and sheaths of the anterior legs, and in general the traces of all that is visible in the external figure of the caterpillar.

The change in the caterpillar is effected by the creature withdrawing itself from the outer skin as from a sheath, when it finds itself incommoded from being confined within a narrow compass. But to accomplish this change is the work of some labour and time. Those caterpillars who live in society, and have a kind of nest or habitation, retire there to change their skin, fixing the hooks of the feet, during the operation, firmly in the web of their nest. Some of the solitary species spin at this time a slender web, to which they affix themselves. A day or two before the critical moment approaches, the insect ceases to eat, and loses its usual activity; in proportion as the time of its change approaches, the colour of the caterpillar declines in vigour, the skin hardens and becomes withered, and is soon incapable of receiving those circulating juices by which it was heretofore nourished and supported. The insect is now seen at intervals with its back elevated, or with the body stretched to the utmost extent: sometimes raising its head, moving it from one side to another, and then letting it fall again. Near the change the second and third rings are seen considerably swollen. By these internal efforts, the old parts are stretched and distended as much as possible, an operation attended with difficulty, as the new parts are all weak and tender. However, by repeated exertions, all the vessels which conveyed nourishment to the exterior skin are disengaged, and cease to act, and a slit is made on the back, generally beginning

at the second or third ring. The new skin may now be just perceived, being distinguished by its freshness and brightness of colour. The caterpillar then presses the body like a wedge into this opening, by which means it is soon torn down from the first to the fourth ring: this renders it large enough for the caterpillar to pass through.

The caterpillar generally fasts a whole day after each moulting, for it is necessary that the parts should acquire a certain degree of consistency before its organs can perform their ordinary functions. Many perish under this operation. The caterpillar always appears much larger after it has quitted the exuvia than before; for the body had grown under the old skin till it was become too large for it, and the parts being soft they were much compressed, but as soon as this skin is cast off, the parts distend, and with them the new skin, which is yet of a flexible and tender texture, so that their increase in size at each moulting is considerable. Some caterpillars in changing their skin alter very much in colour and appearance, sometimes the skin from being smooth becomes covered with hair, or spines, or tubercles, and others that are in one stage hairy, have the skin smooth in the next. No sex is developed in the caterpillar state.

The caterpillars of lepidopterous insects seem destitute of all means of defence, and are the prey of birds and other voracious creatures. Nature has not, however, left the whole tribe in this defenceless state, some kinds are armed with strong and powerful spines disposed in a verticillate manner round the annulations of the body, and which, if they be insufficient to annoy others, serve at least, in some measure, as the means of self protection. There are others, chiefly the inhabitants of the warmer climates, whose bodies present an armament of spines not unlike that of the hedgehog or porcupine, and these placed in such a formidable manner, as must either forbid the approach of other small creatures, or punish their temerity. Some few of the North American species are of this description. In others, we see the rings tuberculated, and every tubercle beset with ramose spines, the branches of which intertexting with each other, form an almost impenetrable net-work of spines. Others again are thickly clothed with spines and hair intermingled, which may be sufficient to guard them against the attack of some of their inferior enemies. Some species with the body covered only with a thin skin, and therefore apparently exposed to the annoyance of every other, has the jaws so powerful, and the disposition so ravenous and fierce, that they constantly attack, and most commonly with success, the larva of other species much larger than itself. At the extremity of the body in the larva of the sphinges, is a remarkable recurvate spine or horn, formidable in appearance, but harmless in its nature, and which is vulgarly supposed to be its weapon of defence. These insects, or at least some of them, are not, however, without the means of annoyance, for it appears they possess the ability of discharging from their mouth or vent a fetid liquor, the scent of which, should it fall on the skin, cannot easily be removed even by washing, and which may be supposed powerful enough to repel other insects. This ability in the sphinx tribe of caterpillars is admitted on the authority of some credible authors; the like circumstance is more commonly observed in the larvæ of some species of tentredo.

The caterpillars of many insects of the butterfly tribe feed close to the ground, or under the surface, subsisting on the lower parts or roots of plants; and for this reason many kinds are seldom seen, and others remain unknown. The larvæ of the sphinx kind live chiefly on the leaves. Those of the scia genus are usually denominated internal feeders, or such as reside in hollow cavities, which they form.

in the trunks or branches of trees, the substance of which also affords them nourishment. Many of the moth tribe are of the same kind, and have the same habits; others eat the leaves of different plants, and a few of the smaller sorts feed on woollen, paper, and other substances, not of a vegetable nature. Some of the lepidopterous caterpillars are solitary, others live in society.

*Neuroptera*.—The larvæ of neuropterous insects are carnivorous, and in the vivacity of their manners exhibit a very striking contrast with those of the generality of insects. They are nearly all of the aquatic kind, passing their whole life, till they assume the winged state, in the water; and are distinguished for the peculiar address with which they constantly wage war, not only against every other diminutive inhabitant of their natural element, but also against each other. These larvæ are hexapode, or furnished with six feet of a scaly nature, and having the head protected by a similar substance.

The libellulæ, or dragon-flies, form an interesting genus of the neuroptera order, and the habits of their larvæ illustrate, in the strongest manner, the nature of these aquatic creatures. The egg, when deposited by the parent in the water, sinks to the bottom, and remains there till the young insect has acquired sufficient maturity and strength to burst from its confinement. The larva, at first small, increases to nearly half the size of the perfect fly, by changing its skin at different intervals like the caterpillars of moths and butterflies. The appearance of the little cases containing the rudiments of the wings, at the lower margin of the thorax, denotes its change to the state of pupa. The head of this larva is exceedingly singular, being covered with a mask extending over the whole of the fore part of the head, with cavities in the interior surface to suit the different prominences of the face to which it is fitted with perfect neatness. Its form is triangular, growing smaller towards the bottom: in the latter part there is a knuckle which fits a cavity near the neck, and on this part it turns as on a pivot. The upper part of this mask is divided into two pieces, which the insect can open or close at pleasure, and it can also let down the whole mask, should occasion require. The inner edges of these two pieces are toothed like a saw, and serve the animal as a pair of forceps to seize and retain its prey. This is the general principle on which these projecting forceps are constructed in the larva of the libellulæ; they differ in shape in the several species, but uniformly act in a similar manner.

These animals generally live and feed at the bottom of water, swimming only occasionally. Their motion in the water can scarcely be called swimming, it is accomplished by sudden jerks repeated at intervals. This motion is not occasioned by their legs, which at this time are kept immoveable and close to the body: it is by forcing out a stream of water from the tail that the body is carried forward, as may be easily perceived by placing them in a flat vessel, in which there is only just water enough to cover the bottom. Here the action of the water squirted from their tail will be very visible; it will occasion a small current, and give a sensible motion to any light bodies that are lying on the surface. This action can only be effected at intervals, because after each ejaculation the insect is obliged to take a fresh supply of water. The larva will sometimes turn its tail above the surface of the water, and force out a small stream, as from a little fountain, and with considerable force.

The larvæ of the ephemere, another of the neuropterous tribes, differ in various particulars from those of all other insects: its length, in the larger species, about an inch; the form rather long, and sub-cylindrical, tapering a little towards the tail: the head is furnished with antennæ, trunk

with six legs, abdomen with several sinny plumes each side, and the tail with three long processes. They live in the water, where earth and clay, it is affirmed, form their principal nourishment for the space of two or three years, the time they consume in preparing for their metamorphosis, and which is accomplished in a few moments. The larva, when ready to quit that state, arises to the surface of the water, and instantly casting off its skin becomes a pupa. This is furnished with a kind of wings, by the assistance of which it escapes to the shore, and there settling, in the same moment, quits a second skin, and becomes the perfect fly. In this state, which has been so long preparing, the pleasures it enjoys must be very sensible, if they are lively in proportion to the shortness of their duration, the insect celebrating its nuptials, producing the fruit of them, and dying within the space of a few hours; the vital principle, though so evanescent in the complete insect, is extremely tenacious in the larva.

The phryganæ, a genus of this order, very much resembling, in general appearance, certain families of the moth kind, are the offspring of aquatic insects, not much unlike the larvæ above described; only that instead of inhabiting the waters in a defenceless state, they constantly live in small cylindrical cases of their own construction, which they drag after them in the water wherever they go. These cases are tubular and open at both ends: externally they are formed with small bits of reed, gravel, small shells, and other substances curiously cemented together, and lined with fine silk. The animal never quits its habitation till it becomes too small for its body, when it constructs another. Like the hermit crab, when it is desirous of moving from one place to another, the animal advances the fore-part of the body out at one end of the tube, so as to admit the free use of its legs, which are six in number, and placed contiguous to the head, and by this means it is able to crawl or walk with perfect facility at the bottom of the water. The body in most species is smooth, and the back usually furnished with a tubercle, which prevents the case from slipping too forward while the animal is feeding, and which serves also to retain the case more firmly to the posterior part of the body in the action of walking. These, in common with other aquatic larvæ, are frequently used by anglers as bait, and are called cadew-worm, stone bait, or cod bait, and in the perfect state is known by the name of spring fly. The larvæ of the phryganæ prefer running waters.

Those above-mentioned are the larvæ of the amphibious kinds of neuropterous insects; there are others which live only on land, and differ much from these both in appearance and mode of life. Those of the myrmeleon, panopa, hemerobius, and raphidia, are of the terrestrial order. They are carnivorous as well as the aquatic kinds, preying on other insects. The most extraordinary of these in their manners of life are such as have been denominated by naturalists the lion-ants, or lion-pismires (the myrmeleon of Latin writers). Of this genus there is nearly a dozen species, or, indeed, if we include the ascalphi which Fabricius removes from that genus, there are altogether sixteen species at present known. The larvæ of this family prey with the most savage ferocity on all the smaller kinds of insects: it is not, indeed, this disposition, so common to all carnivorous larvæ, that renders them remarkable, but the extraordinary and peculiar contrivances they adopt to ensnare their prey. We are best acquainted with the history of the species formicarius, the formica-leo of Linneus, and this may serve as an example of the genus, the habits of which, so far as we are acquainted with them, being alike in all, with this difference, however, in their predatory powers, that formicarius

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is one of the smaller kinds, and less capable, from its inferiority in strength and size, to commit devastation, than most of the extra European species, those of Africa especially.

*Myrmeleon formicarius* is found in France, Spain, and Germany, and is an inhabitant of sandy places. The egg is deposited by the parent insect in the sand, and this hatching produces a larva of an ovate form, armed with a long and powerful pair of jaws. The larva, as soon as produced, begins to exercise its talent of preparing a pitfall in the sand, by turning itself rapidly round, and which, when formed, is somewhat funnel-shaped, or rather concave, with a very small aperture in the centre under which the animal conceals itself with only its pincers advanced through the hole, ready to seize on any insect that may unwarily fall into the hollow. Sometimes the whole head is protruded through the hole, but when it lies in wait the body is always concealed under the sand. From the structure of this trap, such insects as crawl to the edge or sides are almost sure to fall in, and be devoured by the larva. But should the sides of the pit not give way, or the unfortunate insect appear to be able to make its escape, its merciless enemy immediately discharges from its head showers of sand, the repeated force of which is irresistible; the insect falls within reach of the larva, who, after sucking out its juices through the tubular forceps, by a sudden exertion throws the remains of its carcase out of the hollow to a considerable distance, and again, after repairing its den, renews its vigilance for prey. As the larva increases in size, it enlarges this cavity; at first it is only a slight depression in the sand half an inch in diameter, in its next stage it is increased to twice that diameter, and when the larva attains its full size is between two and three inches across. In the preparation or enlargement of its pit, when it grows to its full size, it shews much address: its operation commences by tracing an exterior circle of the intended circumference of the cavity, and continuing its motion in a spiral direction till it reaches the centre, thus marking each revolution in the sand like the impression of a large shell of the whorled kind, the breadth of each whorl corresponding with that of the insect's body; and which, in the circumference of the whole cavity, amounts to four or five circles. After having sufficiently deepened the cavity by a repetition of this motion, it smooths the sides into a regular shape, by throwing out the superfluous sand by means of its forceps, which, when closed, together with the head, forms a convenient kind of shovel for the purpose. The grains of sand thus discharged often fall to the distance of ten or twelve inches beyond the verge of its cavity. The depth of the cavity is usually equal to its diameter. The singular larva, whose manners of life appear so interesting when it has attained its full size, is about three quarters of an inch long, and has much the aspect of a large spider in the form of its body: its head and legs more nearly resemble those of the pediculi of some particular animals, and are very small, and in the structure and proportion of the jaws or forceps its character is peculiar, these being enormous. Its general colour is pale reddish, very prettily variegated with distinct marks and spots of deep ferruginous both on the back and belly; the whole is beset with a few hairs, some of which appear in tufts. It remains two years in the larva state; in the summer it is active, but it is torpid during winter; when full grown it changes into a pupa, the animal previously enveloping itself in a round ball of sand agglutinated and connected by a very fine silk, which it draws from a tubular process at the extremity of the body; with this silk it also lines the internal surface of the ball. The complete insect is furnished with four transparent spotted wings, and, like the larva, preys on insects.

*Hymenoptera*.—The larvæ of the teredines bear the nearest resemblance possible to those of some lepidopterous insects, and have for this reason acquired the name of bastard caterpillars, or false caterpillars; the spiral manner in which they roll themselves up is one character that seems to remove them from the true caterpillar, but they are more clearly distinguished by the number of feet, which, though varying in different species of both families, may be said to be constantly more numerous in the tenthredo genus than in any of the lepidoptera orders. The first have from eighteen to twenty-two feet; the latter never more than sixteen, including the spurious or posterior ones. These live chiefly on the rose and willow trees. The larvæ of the *firex* genus is cylindrical, and furnished with six feet, and the head rounded; they perforate wood, and frequently eat their way into the bodies of other insects, or their larva, and consume their vitals. These are the principal hymenopterous larvæ that are furnished with feet: the succeeding insects are destitute of those organs when in the larva state.

One of the most curious tribes of larva among the hymenopterous genera are those called the gall-flies; they are in no particular manner remarkable in appearance, but the effects they produce render them extraordinary. Every one must have observed those vegetable excrescences, of a globular form, which appear on the leaves and foot stalks of the oak at particular seasons of the year, and which in autumn have acquired the size of a cherry or a small plumb, its colour a bright red, and forming a pleasing contrast with the verdure of the leaves; these are the habitations formed by the punctures of the gall-fly, in which the eggs were deposited each singly in its globule by the parent insect, and each of those excrescences at this season, on being opened, will be found to contain a larva; a small worm of a cylindrical form and without feet. There are an amazing number of species of the gall-fly (*cynips*) that construct their dwellings, and subsist on the juices of the oak, and many others that attack in like manner the maple and the willow. The larva is found like a nucleus, in a small cavity immediately in the centre of each excrescence.

The manners of the ichneumon, as popularly described, are fully known, and the history of the ichneumon flies seems to accord in a peculiar degree with all that has been fabulously related of the former. They are entirely parasitical, and derive their sustenance, till they arrive at the perfect state, from the vital juices of other insects. Their eggs are deposited only in the bodies of other living insects, generally those of the caterpillar kind. The female, selecting her victim, fastens upon it, plunges her abdominal tube into the body, and, in despite of all resistance, maintains her hold till she has lodged her store of eggs. In the course of a few days the young larvæ, which resemble minute maggots, are hatched. These nourish themselves with the juices of the caterpillar, which, notwithstanding it affords sustenance to the parasitical brood, continues to move about, and feed till the time of its change into the chrysalis state, when the larvæ creep out by perforating the skin in various directions, and form little oval silken cases, the whole of which with the spinning forms an envelope to the withered remains of the insect from which they derived nurture. The latter inevitably perishes from the injury sustained; in a shorter or longer period, according to the species, the ichneumons appear in a perfect state. This parasitical family, when produced, are found to be either entirely of the winged kind, or to consist both of alated and apterous insects, the females in certain species being destitute of wings. These are, notwithstanding, perfect insects, as they never acquire those organs afterwards, and being besides, after an intercourse with

the other sex, in a condition to deposit fertile eggs, and thus perpetuate the breed. The apterous females attack caterpillars and other insects in the same manner as the winged kinds, and deposit their eggs in the living body.

So far as we are acquainted with the natural history of the sphex tribe, the larvæ of these are lodged in the bodies of other insects, in a manner similar to that adopted by the ichneumons, with this difference, that the sphex generally destroys the principle of life in those creatures it attacks, instead of leaving them to linger through a tedious existence of torture. These insects are very abundant in wood and hedges, and the larvæ feed chiefly on dead insects, in the bodies of which they are produced from the egg. Some species dig holes in the earth with their fore feet, in which they bury their dead insects, consulting chiefly of spiders and caterpillars, having previously deposited their eggs therein; these holes are carefully closed with earth or clay, through which the larvæ force a passage when hatched. The larvæ are vermiform. The manners of these insects is strongly exemplified in the species *sigulus*, a native of Upsal, and which is described by writers with considerable attention. This sphex inhabits the holes in old wooden partitions, abandoned by other insects, the interior of which the female cleanses by gnawing the surface of the cavity throughout, and prepares it for the reception of her victim, by placing a piece of clay in the bottom. She then seizes on a spider, which having killed, and flattened upon the clay, she next proceeds to the deposition of the egg, which is lodged in the dead body. This laid she closes up the opening with clay. The larva hatched from the egg resembles the maggot of the bee, and which, having devoured the food provided for it, spins itself a silken web, and changes to the pupa state. In this manner each female insect prepares several separate holes, in each of which a dead insect and an egg are deposited. The larvæ of wasps and bees are soft, without feet, and feed on the nectar and honey collected by the parent insects. The larvæ of the ants are also well known. The three latter mentioned families live in societies, and with those already noticed form the principal kinds of hymenopterous insects.

*Diptera*.—These larvæ vary much in different genera. Commonly they appear like a small worm, the likeness to which is heightened by the animal having no feet, and in some species by the head being soft, like the body. Others differ in having the head scaly. The larva of the oestri, or gad-flies, deposits its eggs in various parts of the bodies of cattle, which, when hatched, produce the most painful tumours. Some lay their eggs under the skin of cows or oxen, which they perforate for that purpose: others enter the intestines of horses by the vent; and others, again, deposit them in the nostrils of sheep. The larva of *oestrus bovis* is brown, and consists of eleven segments, with transverse rough interrupted lines. That of *equi*, known by the name of bots, deposits its eggs on the hairs of horses, and always on those parts which are most likely to be licked with the tongue, and are thus conveyed into the stomach. The eggs of *hæmorrhoidalis* are laid on the lips of horses, occasioning a titillation, which causes the animal, when attacked by it, to move its head violently, and gallop about with every symptom of distress: this larva is carried into the intestines like the former, and is voided with the dung when its period of change to the pupa state approaches.

In the genus *tipula* the larvæ are soft, cylindrical, and truncated at the head: these feed on the roots of plants. The larvæ of the different natural tribes, comprehended among the Linnæan muscæ, exhibit some very dissimilar ap-

pearances in form and habit. Generally, they possess a worm-like aspect, sometimes blunt at the anterior part, and acute behind, and at others pointed at both ends. Many live in watery places and devour insects; others feed on decaying animal matter, or on the juices of vegetables. The larvæ of *musca vernileo* preys on insects, and in its mode of entrapping its prey imitates the manners of *myrmoleon formicarius*, like that ferocious insect forming a circular den in the sands which it inhabits, and watching in an aperture at the bottom for the unwary insects that unfortunately wander too close to its cavity. But of all the peculiarities related of the musca tribe, nothing appears in any degree so extraordinary as the history of the larva of *musca tenax*, recorded on the authority of Linnæus, and sanctioned by that of Fabricius. The larva is represented as a brown maggot with a long tail, which latter is extensible, and consists of a double tube, the exterior annulated into numerous segments, and the interior slender and terminated by a circle of hairs, surrounding a spiracle. This maggot is seen in muddy stagnant waters, drains, and other similar places; and is, according to Linnæus, a frequent inhabitant of the turbid pulp used in the operation of paper making. Hence it is often in this state exposed to the action of the wooden mallets used in this process, as well as squeezed in the strongest presses, and yet it survives uninjured these seemingly destructive operations.

This circumstance is described in a paper entitled "*Miracula Insectorum*," inserted in *Am. Acad.* 3. p. 331, and though purporting to be the production of Emanuel Avelin, obtained the sanction of Linnæus. The same observation is confirmed in the "*Systèma Naturæ*;" and is repeated in this place as a most extraordinary trait in the history of this insect, without deeming ourselves in the least responsible for its veracity.

The tabani nourish themselves with the blood of horses and cattle; and some think the larvæ are aquatic, though Degeer asserts they live under ground. The larvæ of culices (gnats) are very curious in their conformation: the body consists of nine segments, which become gradually smaller from the head towards the extremity. The head is very large, and furnished on each side with a pair of pointed forceps, or hooks, with which it seizes its prey. The tail terminates in a tubular opening, at the tip of which are four ovate scales, two of which exceed the others in size. At the end of the body, near the tail, is a small elevated respiratory tube, which the creature frequently raises above the surface of the water, while the head remains suspended downwards. The colour of the larva is brownish, extremely pellucid, and its motions remarkably lively. The larva, when first hatched, is extremely minute, and in the space of fourteen days from its birth attains its full size, its length being then about half an inch. The painful sensation occasioned by the sting of the gnat, or, in other words, its sucking proboscis, is well known, and hence we are taught to consider the gnat as an insect subsisting only on the blood of other animals: this is not, however, the opinion of some naturalists, who, reflecting on the myriads of these creatures, with which every watery place is infested, conclude they could not find sufficient sustenance, unless they subsisted equally on the juices of vegetables and animals. Whatever may be the truth in this respect, the weapons of annoyance with which nature has furnished the larva indicate very clearly to us that in that state, at least, it is of the carnivorous kind. We shall lastly mention the *hippoboscæ*, a dipterous genus in the Linnæan system, and which, unlike those before adverted to, do not appear to have any larva; they are the produce of an egg which partakes of the two-fold

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fold character of being at the same time an egg and a pupa. The female, at distant intervals, deposits an egg, which in magnitude is nearly equal to the whole bulk of its parent's body: the figure of this egg is oval, with an excavated depression at the lower end; the colour, at its first exclusion, is milk white, except a large black spot on the fore part, from which it afterwards becomes brown, and then of a jet black, with a very high polish. This change in colour marks the progressive advancement of the insect inclosed towards its maturity of formation, the parts becoming gradually developed. The egg deposited in autumn acquires its deepest colour in the summer following, at which time the insect bursts from its confinement in the winged form.

*Aptera*.—No insect of this order, except the common flea, are supposed to undergo those successive changes which are usual in most other insects. They are almost entirely produced from the egg in their perfect form, and cannot therefore be said to have any larva. In the flea, however, the small worm which corresponds with the larva in other insects is clearly ascertained; and if we may place sufficient reliance on the evidence of certain naturalists, one or two more of the apterous genera exist for a short period in a state somewhat analogous either to the larva or pupa. Leeuwenhoek observed that the mite was oviparous, laying very small oval whitish eggs, from which proceeded the young animals, resembling their parents in all respects, except in the number of their legs, these being only six in number, instead of eight; and after they cast their skin another pair of legs appear, a fact that evidently implies two periods of transformation, the first of which may be compared with that of larva. An advancement, or progressive increase in the number of feet, is also well known to take place in species both of the julus and scolopendra genera, after they are produced from the egg state. The julus fabulosus, when first excluded, is furnished with three pair of legs, which are situated at each side near the head: some days after about fourteen become visible, and the remainder, to the amount of one hundred and twenty on each side, are gradually acquired afterwards. The same remark will apply to certain species, if not the whole of the scolopendræ genus. Scorpions are produced by the female parent in a living state; they are at first very small and white, and become of a darker hue in a few days: these, like the spiders, cast their skin as they increase in size.

### *Of the Pupa state.*

By this term, as understood in the very extensive sense Linnæus proposes, we comprehend that state of an insect which succeeds the larva and precedes the pupa, without any regard to the particular appearance it assumes in this stage of transformation. From this latitude of meaning it includes, therefore, with equal precision, and no less propriety, states of the most discordant character. It alike implies the uncouth grub incased in its shelly repository, and immured in the earth, sluggish, almost destitute of motion, or the appearance of any other animal function, with the lively half-winged locust, or the cicada, animals sporting in the full enjoyment of life. The bot, imprisoned in its oval covering, without the least external sign of animation, is termed a pupa. The moth, quiescent and abtinent for months, concealed in its shelly covering in the earth, or suspended aloft in its silky envelope to the branch of a tree, is a pupa; and we denominate those pupæ also which have the wings only half expanded; though, like the nimble-footed cimex, they are perpetually roving, and deriving sustenance from the blood of other animals; and so also the restless libellula, which is continually traversing the watery

element, with the facility of fishes in search of prey. Surely the difference between these is too great to be defined by any single term.

Writers have observed, that before the time of Linnæus this state of transformation was known only by the term chrysalis, a word derived from the Greek, and expressive of that golden lustre peculiar to certain butterflies; but this appearance not being general, the word was changed by Linnæus to that of pupa, in allusion to the indistinct resemblance which many insects in that state bear to a child swathed or dressed in swaddling clothes. These observations are certainly incorrect, for the word nymph, implying exactly the same fanciful comparison, was in use before the time of Linnæus; the earlier authors so named one particular tribe of insects in this state, namely, those having all their limbs inclosed within a skin: Linnæus adopted the idea but changed the word to pupa, and assigned it indiscriminately to all insects in that period of transformation from which the perfect fly is produced.

If we take a retrospective view of the state of entomology before the time of Linnæus, and consider attentively the terms by which the different states of insects were then known, there does not appear much reason to commend the alterations which he has introduced. From the labours of Swammerdam, Reaumur, Roefel, Lister, Ray, and others, the transformations of insects were then generally known, and particular terms had become established by which the several states, appearances, &c. might be discriminated. These were not sufficiently numerous, and of those in use some were less expressive than could be wished; but it is still not to be concealed that some, at least, were preferable to those introduced by Linnæus. This is the more to be regretted, as Linnæus wrote under favourable circumstances, and on his authority the introduction of a few expressive terms would have been attended with particular advantage. For instance, we should have conceived it desirable if he had designated this state of insects, which he calls pupa, by different terms, applying to each particular family a name at once expressive of their state, and the order to which they belong. When, in the works of his predecessors, we read either of the aurelia, nymph, or semi-nymph, we know that in a word it implies the same state as Linnæus means by pupa, with this additional information, that it is either of the dormant kind, like the moth, or active, like the nepæ, &c.; the Linnæan name conveys no such additional information; it applies without distinction to all, and merely intimates its state of transformation.

Perhaps the alteration of the word chrysalis to pupa may be thought by some an amendment; we do not disapprove of it, but object to the very indiscriminate sense in which it is employed. As it applies to the nymphs of one family described by earlier writers, it is admissible; to others it is not. Or if the term pupa were adopted in its most extensive sense, to comprehend this state throughout the whole race of insects subject to this period of transformation, the want of terms to distinguish the particular tribes of which they consisted would be equally felt. The general manner in which the term pupa is applied by Linnæus, and the inconsistency attending it, cannot be more fully exemplified than by the following circumstance. Linnæus, we are told, changed the word chrysalis to pupa, because the former implied a golden appearance not observable in all the species; yet he applies the word pupa, which he defines as alluding to the appearance of a child in swaddling clothes, such as we see in the moth and butterfly tribe, to the blatta, gryllus, cimex, and a host of other active creatures which exhibit no such resemblance, and which bear

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no relation whatever to the others either in manners or aspect! The first of these were called by old writers nymphs, the latter semi-nymphs; but these distinctive terms are confounded by Linnæus under the single term pupa. Surely the impropriety is as great in the alteration made as in the error it is designed to remedy.

To obviate, in some degree, the confusion arising from this general adoption of the word pupa, Linnæus proposed afterwards to divide them, according to their form, into five families, to each of which he assigns a trivial or secondary name.

These distinctions are not objectionable, but are rather too few in number, and they are certainly not expressed in terms suitable for general use. Nor does Linnæus himself appear satisfied with them, for although they are inserted with definitions at some length in the "Fundamenta Entomologia," they are not adopted in the "Systema Naturæ," and are for this reason rather to be regarded as matter of curiosity than of utility. The pupæ are divided into sections, according to the following circumstances. When confined in a case of a globular form, which has no resemblance to the insect it contains, it is called *coarctata*, or straightened, the examples of which are the musci and oestri; *obscûta*, disguised or shrouded, when the insect is wrapped up in a shelly covering of such a form that the part which contains the head and thorax may be distinguished from that wherein the abdomen is lodged, as in lepidopterous insects. It is termed *incompleta* when the pupa has perceptible wings and feet, but cannot move them: *semi-completa*, these can walk or run, but have only the rudiments of wings. The difference between the pupa and the larva of this class is very inconsiderable; in the first state they have no wings, and in the pupa the wings begin to be developed as in the grasshopper: *completa*, in which the egg may be considered analogous to the pupa, the insect being produced in its perfect form from the egg without passing through any other change.

Swammerdam divides insects into four classes, the characters of which are founded principally upon their appearance in this state of transformation, and the particulars attendant thereon.

The first of these comprehends those insects which, after being formed in their egg without the aid of food, and which, after having acquired, by the evaporation of the superabundant humidity, the necessary consistency, quit that state, and issue from the shell under the form they are to retain during life, without undergoing any other transformation, as instanced in the spider.

The second consists of those insects which, after leaving the egg, are without wings, but with all the other members, as in the perfect insect; in this state they eat and grow, pass into the nymph form, and from that issue with perfect wings, and with the ability to propagate their species. The dragon flies, grasshoppers, and cimices are of this family.

The third includes all kinds of butterflies and moths. They issue from the egg which lay in a disguised state and without food; the second state eats and grows, and the members of the animal into which it is to be transformed are formed under the skin, which it at last quits and becomes a nymph, and then after the evaporation of the superfluous humidity produces the perfect insect.

The fourth family, after having arrived at the nymph state, like those before-mentioned, does not divest itself of the skin in order to enter into that state, but assumes the form of a nymph under its skin, where it continues shut up, till quitting two skins, at once it comes forth in its perfect state. This is the metamorphosis which ichneumons undergo. These are the four families into which Swammerdam divides insects,

and the explanations he affords; and these, with some improvements and modifications, form the basis upon which the pupæ are arranged by many of the continental naturalists at this time.

The following observations on the same subject by Lyonet deserve attention. "By the term nymph (says this writer) is meant a state of imperfection, attended sometimes with inactivity, inaction, abstinence, and weakness, through which the insect passes, after having attained a certain bulk, and in which its body receives the preparatives necessary for its passing to a state of perfection, all the external parts of the insect are then found enveloped, either with their natural skin, or with a fine membrane, or with a hard and crustaceous crust. In the first case the limbs of the insect remain free, it preserves its power of acting, it eats, and its form is little different from what it was before. In the second case the limbs of the insect are folded over the breast but separate; it can neither eat nor act, it retains hardly any traces of its former figure, and has only a confused resemblance to that which it is going to assume. In the third case, the cover brings all these parts of the animal into one mass; it makes it equally incapable of eating and acting; it has no resemblance either to what it formerly was, nor what it is to be. These three sorts of change are evidently very different, and yet we have only two words in our language (French) to distinguish them by. We say of the insects in the two first cases, that they are changed into nymphs, and of those in the last case that they have assumed the form of chrysalids. To these terms it would be proper to add a third, in order to mark the difference between the two first. It might be done I think very conveniently by allowing the last to retain the name of nymph, and calling those of the first kind semi-nymph, or demi-nymph, a name which would not perhaps be inapplicable to them, considering the small degree of change they have undergone. Grasshoppers, which, instead of the long wings they acquire, have still only on their backs the small cases in which these wings are formed, are nymphs of this kind; they may properly be called semi-nymphs. Those who have had an opportunity of examining a bee hive, cannot fail to have remarked bees still imperfect in the shut cells; these are the nymphs of the second order. The silk-worm furnishes a well known example of insects under the form of chrysalis.

"Insects which undergo no other metamorphosis than that which has converted them from the soft substance of an egg to a well formed and living body, are those which constitute the first class of transformations spoken of. They increase in size, the greater part cast their skin; some of their parts acquire greater size than the rest, and sometimes take a different colour from what they had before. This is almost the only change they undergo. The transformations of the insects of the other three classes do not terminate here; after having cast off their skins for the most part several times, and after having acquired their destined bulk, all become either semi-nymphs, nymphs, or chrysalids. They pass a certain time under this form, and upon quitting it assume that of a perfect insect, capable of generation. It is from the diversity which takes place in these three sorts of changes that the principal characters, which distinguish the insects of the second from those of the third, are taken."

The insects of the second class are those that pass through the state which Lyonet calls semi-nymphs. They do not undergo a transformation which is entirely complete, but in their last change they have still generally all the members they had before, without having acquired any others, except

cept they have wings; and as already remarked the semi-nymph differs very little from the animal which produced it. What always distinguishes it is, that there are seen upon its back at the base of the thorax the cases in which the wings are formed, which before that appeared but little, and often not at all. In other respects it walks, runs, leaps, and swims as before. The difference between the semi-nymphs, and the winged insect which it produces, is not always so obscure. In some species it is so large that it is with difficulty we can discover its first form. But the greater part in their last state differ chiefly in the wings.

The insects of the other two classes do not enjoy the same advantages as the other. They lose the use of all their members when they enter upon their transformation, and have no resemblance to what they were before. An animal of these two classes which before had no legs, or had five, six, seven, eight, nine, or ten pairs, has now no more than three pairs, which, with the wings and antennæ, are folded up under the breast and remain immovable.

What distinguishes these two last classes from each other is, that the insects of the third class quit their skin, when they change into nymphs or into chrysalids, and that those of the fourth change into nymphs under their skin, which hardens round them, and forms a case.

Reaumur found, in the transformation of insects of the fourth class, a character that seems to distinguish it essentially from the rest, namely, that they changed into nymphs without quitting their skin. He discovered that they undergo one transformation more than other insects; because before they become nymphs, they assume under their skin an elliptical form, or that of an elongated spheroid, in which no part of the animal is discernible; that in this state the head, thorax, wings, and legs of the nymph are inclosed in the interior cavity of the abdomen, from which they issue successively by the anterior part, nearly in the same manner as the extremity of the finger of a glove, which has been drawn in, is pushed out again. Thus, the insects of this class are not solely distinguished from others by their changing into nymphs under their skin, but principally in undergoing a double transformation before they become nymphs.

Bergman distinguishes three kinds of pupa, which he calls chrysalids, nymphs, and semi-nymphs. The first he describes as hard and motionless, that does not eat, and shews obscurely the members of the future insect; the nymph is tender, lying at rest, not eating, and which shews clearly the separate members of the future insect; the semi-nymph is furnished with legs, and runs, eats, and is hardly different from the larva, except in having the rudiments of the wings, which the larva wants.

This inquiry, if duly pursued, would lead to much farther digression. From what is already advanced we presume it will be apparent, that the writers prior to the time of Linnæus, or cotemporary with him, (for those alone are mentioned,) are not agreed in their manner of distinguishing insects in this third state of transformation; and that their appearance is so various in different tribes, while in this state, that they ought to be distinguished by several, instead of a single name. Fabricius, one of the most considerable entomological writers since the time of Linnæus, employs the word pupa in the same general sense as the latter; but he is the principal late continental writer worthy of consideration, who has imitated this example. The French naturalists chiefly follow Lyonet, with some slight variation. This arrangement is still susceptible of much improvement, but is notwithstanding perhaps the most perspicuous yet proposed. To the chrysalis properly so called, namely,

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those of the butterfly tribe, this name given to them by the Greeks is retained; the rest of those which have their members enveloped in a common skin are called nymphs, and are divided into three or four families, according as those parts are more or less visible through the exterior membrane. The term *fève* (bean) is also introduced, to express in a general manner this state of the insect, when of an oblong form, and distinguished only by a few annulations and eminences. Insects in the third state, which differ only from the perfect form in having half-wings, are called semi-nymphs.

In the present section, to avoid confusion, it may be more convenient to adopt the Linnæan term, and under this head, describe such of the leading differences in insects as are observable in this state of transformation.

*Coleoptera*.—The nymphs or pupæ of this order have commonly the limbs detached or not laid under the exterior envelope close to the body, as in lepidopterous insects. Most of them bury themselves in the earth previously to this change; some form cells in decayed trees, others perforate seeds and nuts, and great numbers remain in the dung of animals, or other filthy substances, where the larvæ have been nourished. Their appearance, while in this state, is nearly the same in all, an emollient pupa of a whitish colour tinged more or less with brownish, and in form remotely resembling that of the moth kind, but with the limbs distinct. The mutations of *scarabæus nasicornis* affords an interesting description of the pupa of a coleopterous insect, and may serve as an example for the rest of the tribe. When the time approaches for this larva to change into the pupa form, it penetrates deeper into the ground than the larva had done before. Having found a proper place, it forms with the posterior feet a polished cavity, in which it remains for some time immovable; after this, by voiding excrementitious substances, and the evaporation of moisture, it diminishes in size, and the skin becomes furrowed and wrinkled, as if the animal were partly starved. If dissected at this time, the head, belly, and thorax may be distinguished. While some external and internal parts are changing by a slow accretion, others are gently distending by the force of its impelled humours. The body, contracting itself while the fluid is propelled towards the fore parts, forces the skull open in three parts, and the skin in the middle of the back is separated by means of an undulating motion of the incisions of the back; at the same time the eyes and the horns, &c. cast off the exuvia. During this operation, a thin watery humour is diffused between the old and new skin, which renders the separation easier. The process going on, the larva is at last disengaged from its skin, and the limbs and parts are by continual unfolding transformed into the pupa state: after which it twists, and compresses the exuvia at the vent, and throws it towards the hinder parts under the belly. The pupa is at this time very delicate, tender, and flexible, and affords a curious spectacle.

The pupa of this beetle weighs, a little time after its change, much heavier than it does in the beetle state, which is also the case with the bee and the hornet, which latter have been known to weigh ten times as much as the insect when perfect. If the skin be taken off at this time, many curious circumstances may be noted, but what claims our attention most, is, that the horn which is so hard in the male beetle when in a state of maturity, that it may be sharpened on a grind-stone, in the pupa is quite soft and like a fluid. How long this particular remains in this state is uncertain, some beetles of the same kind rest in this form the whole winter, more particularly those who quit the larva state in autumn. Some beetles go through all the stages of their

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existence in a season, while others remain two or three years even in the pupa state.

When the proper time for their final change arrives, all the muscular parts grow strong, and are thus able to shake off their last integuments, which is performed exactly in the same manner as in the passage of the insect from the larva to the pupa state, so that in this last skin, which is extremely delicate, the traces of the pulmonary tubes that have been pulled off and turned out again become visible.

*Hemiptera*.—The pupæ in this order are the semi-nymphs of the old writers, and resemble the perfect insect in size and figure, but are without wings. The rudiments of these members, of larger or smaller dimensions in different species, are situated at the posterior parts of the thorax. They have the same manners, and subsist on the same food as the perfect insects; and we have reason for suspecting that some at least of these are not deficient in any of the animal functions.

*Lepidoptera*.—When the caterpillar of a butterfly or moth has attained its full growth, some writers affirm, that the rudiments of the perfect fly may be distinguished upon accurate investigation beneath the skin. This is asserted by Swammerdam, who declared he could demonstrate all the parts of the future butterfly in a caterpillar near the change. To discover this, it is directed, that the caterpillar be taken at the time the skin begins to open, when it is to be drowned in spirit of wine or some strong liquor, and to be left therein for several days, that it may take more consistency and harden itself, the skin of the caterpillar must be then removed, which will be easily accomplished, and the inclosed moth will appear. The rudiments of the future insect are extremely tender, and should be touched with the utmost delicacy, when the legs, antennæ, and other parts, may be unfolded and displayed to view. The parts of the moth or butterfly are not exactly disposed in the same manner in the body of the caterpillar, as when left naked in the chrysalis. The wings are said to be longer and narrower, being wound up in the form of a cord, and the antennæ are rolled up on the head, but in a very different manner from what it is in the perfect insect, and different from that in which it lies in the chrysalis; so that it is by a progressive and gradual change that the interior parts are prepared for the moth and pupa state; and even the eggs, hereafter to be deposited by the perfect animal, are to be found both in the caterpillar and pupa, the whole arranged in their natural and regular order.

Many of the chrysalides of the butterfly tribe possess a peculiar lustre in colour and brilliancy, resembling gold. It is not an appearance common to all butterflies, it is confined to certain species, and is not seen in any of the pupæ belonging to the moth tribe. This colour does not appear immediately in the chrysalides, but is assumed by degrees as the inclosed insect acquires consistency. It owes its splendour to the lustre of the white or light colour of the inclosed animal shining through the yellow transparent membrane of the case, as M. Reaumur has described in his work. This metallic appearance seems to have afforded a favourable pretext to the alchemists of former days, who were weak enough to draw delusive hopes from this appearance, and conceive it would afford them gold.

The following very curious and indeed instructive description of the chrysalis of a butterfly is given by our countryman Lister, nearly half a century before the science of entomology had made any considerable progress on the continent of Europe, and from which it would appear, that in his time the knowledge of that science was in a great measure confined to this country: it is from his annotations on the works of Goedartius.

“The middle state or disguise of a butterfly is called by the Greeks *chrysalis*, or a thing gilt, as the word importeth: the Latin hath left us no name that I know of; we have translated it *aurelia*. The Latins, however, call the caterpillar *eruca*; which is a word (as I guess from a place in Vitruvius), which signifies in the old Tuscan language *viride æris*, and thence borrowed to signify a caterpillar: for some caterpillars there are, which I have seen in Languedoc feeding on a certain common tithymal, very notably painted with a sea-green colour, or blue. So that as the gilding of some few chrysalides gave a denomination to all; in like manner, the blue colour of some one caterpillar gave the name to all the rest: as for the gilding itself, I take it to be nothing else but the scum of an evaporated juice between the skin of the caterpillar and the shell of the chrysalis, which last it covers.”

The butterfly remains only a short time in the chrysalis state, the interval between the larva and perfect state seldom exceeding ten, twenty, or thirty days. These chrysalides are commonly suspended by means of a few silken threads with the head downwards to the leaves or stems of trees, or against palings, &c. The chrysalis of the “common garden-white” is a familiar example of this mode of suspension, and of the brilliant appearance which this order of insects assume in this state.

The moth tribe remain much longer in the pupa form, and evince more care towards themselves, in making choice of a situation adapted to this defenceless stage of life. The caterpillar having acquired its full size, seeks for a proper place in which it may remain in safety during this period, and having made choice of this, prepares for the important change. Some spin webs or cones in which they inclose themselves, others conceal themselves in little cells which they form under ground, &c. Preparatory to the change the larva ceases to take any food, empties itself of all the excremental matter which the intestines contained, voiding at the same time the membrane which serves as a lining to these of the stomach. It generally perseveres in a state of rest and inactivity for several days about this time. In proportion as the change into the pupa form approaches, the body is observed to extend and contract itself very often: the hinder part is first disengaged from the skin; and after a while the skin is entirely cast off.

The caterpillar, thus stripped from its skin, is called the pupa; the exterior covering gradually becomes hard; while the interior remains so soft that the slightest touch will decompose them. The exterior covering is at first covered with a viscous fluid, which thickening and drying up, forms a thin skin or coat capable of resisting external injuries. Those who are desirous of tracing the various members of the future butterfly or moth in the pupa, should examine it before this fluid dries up.

The length of time an insect remains in the pupa form varies much in different species. As soon as the inclosed animal acquires sufficient strength to break the bonds of its confinement, it makes a powerful effort to escape. The moth frees itself from the pupa with greater facility than the pupa from the caterpillar; for the case of the pupa becomes so dry, when the moth is near the time of throwing off its covering, that it will crack and break to pieces if it be only gently pressed between the fingers; and very few of the parts will be found, on examination, to adhere to the body. Hence, when the insect has acquired a proper degree of solidity, it does not require any great exertion to split the membrane which covers it: a small degree of motion, or a little inflation of the body, is sufficient for this purpose; these motions reiterated a few times enlarge the hole,

hole, and afford the moth room to escape from its confinement. The opening through which they pass is always at the same part of the skin, a little above the trunk, between the wings and a small piece which covers the head: the different fissures are generally made in the same direction. If the outer case be opened, it is easy to discover the efforts the insect makes to emancipate itself from the shell. When the operation begins, there seems to be a violent agitation in the humours contained in the little animal; the fluids being driven with rapidity through all the vessels, the limbs and various parts of the body are put in motion, and by repeated efforts it breaks through the brittle skin that envelops it. Those inclosed in cones or cases, after bursting through the pupa covering, have another difficulty to overcome, that of piercing through the inclosure, which, in many instances, is of a stronger texture than the case of the pupa. For the accomplishment of this, most insects are provided with a liquor, which they discharge from the mouth upon that part of the cone through which they intend to escape, and this so moistens and weakens it, that after a short time they force their passage through with some facility. Some insects not provided with this fluid leave one end of their cone weaker than the rest, and close it only with a few threads, so that a slight effort of the head enables the insect to burst from its prison.

The butterfly or moth, on emerging from the pupa, is moist and humid, the abdomen swollen, the antennæ bent down, and the wings crumpled, small, and shapeless. These parts gradually change and assume their destined form. The wings extend, and the fibres, which were at first flexible, become hard and rigid like bone. In proportion as the fibres lose their flexibility, the fluids which circulate within them extend, and the wings cease to act; so that if any extraneous circumstance arrests the progress of this fluid through the fibres, at the first instant of the moth's escape, the wings immediately become crippled, and never afterwards assume any other form. These parts expand with such rapidity, that the naked eye cannot entirely trace their development. The wings, which at one instant are small and like four little buds at the sides of the thorax, in a few minutes after acquire their full size, so as to be nearly five times as large as they were before. Nor are they the wings only which are thus increased: all their spots and marks, heretofore so indistinct and small as to be scarcely discernible, are proportionally extended, so that what before appeared as only so many unmeaning and confused points, become distinct and beautiful ornaments. When the wings are unfolded, the tongue rolled up, the mouth sufficiently dried; and the different members strengthened, it takes its flight. Most insects, soon after they have attained their perfect state, void an excrementitious substance, which some suppose to be the last they eject during life.

If the moth be now opened down the belly, and the fatty parts which fill it be removed, the gross artery or heart will be visible, and the contractions and dilatations, by which it pushes forward the liquor it contains, may be easily observed. One of the most remarkable circumstances is, that the circulation of this fluid in the moth is directly contrary to that which took place in the caterpillar. In this it moved from the tail to the head, whereas in the moth its current is from the head to the tail. The intestines are now formed in a more delicate manner, and suited to a purer aliment than that on which it subsisted before its change into the pupa: the caterpillar devoured the grosser parts of vegetables; the nutriment of the perfect insect is the nectar of flowers. Many internal parts of the caterpillar disappear in the pupa, and many that could not be before perceived

are at length rendered visible. And thus the creature, which heretofore crept on the earth, flies freely through the air, and, far from creating aversion by its foul appearance, now attracts attention by the elegance of its form and beauty of colour.

The industry of the caterpillar in the construction of its cocoon, or other repository, in which it passes the time destined for it to remain in the pupa state, is highly worthy of remark. Some caterpillars, towards the time of their change, suspend themselves from the branch of a tree, with the head downward, and are transformed in this position. Many of the moth kind cover with threads that part of the branch from which it means to suspend itself: it places these in different directions, and then covers them with other threads successively, till the cone in which it is to become a pupa is finished. The caterpillar hooks itself by the hinder feet to this hillock; and when it has found by several trials that it is strongly fixed thereto, throws itself forward, letting the body fall with the head downwards. Soon after it is thus suspended it bends the fore part of the body, which posture it retains for some time; then stretching the body, again in a little time beading it, and so on, repeating this operation till it has formed a slit in the skin upon the back. Part of the pupa soon forces itself through this, and extends the slit as far as the last crustaceous feet: the pupa then forces upwards the skin, by means of its little hooks, and the motion of the body, till it has slipped it off to that part from which the caterpillar had suspended itself.

The mode of suspension adopted by some insects is very different from that pursued by others. Some fix themselves in an horizontal position, by means of a girdle, which they tie round the body, so as to support the caterpillar, and yet leave it at full liberty to effect the changes: others suspend themselves in webs, in temporary habitations, formed by weaving together two or three leaves of the plant on which they feed, by means of silken threads. The industry of those which spin cones or cases, in which they inclose themselves, in order to prepare for their transformation, is very generally known from the familiar history of the common silk-worm, an insect from which man derives the most essential benefits. In northern Europe these advantages are scarcely known, and are esteemed valuable only in proportion as they contribute to the luxury of dress; because our woollens are better suited to the vicissitudes of the climates. But in a far more extensive portion of the habitable globe, silk constitutes an article of the first necessity in useful clothing; and hence the labours of this industrious little creature become in the highest degree important and beneficial to the human race.

The silky tissues of this insect are spun by the caterpillar, for the sole purpose of enveloping and suspending itself in security during its pupa state. The substance of which the silk is formed is a fine yellow transparent gum, contained in two reservoirs that wind about the intestines, and which, when unfolded, are about ten inches long: they terminate in two exceeding small orifices near the mouth, through which the silk is drawn or spun to the degree of fineness which its occasions may require. This apparatus has been compared to the instrument in use for drawing gold and silver into threads. Each thread proceeds from the two reservoirs at the same time, but they are united as the thread forms; so that, if examined by the microscope, it will be found to consist of two cylinders or threads glued together, with a groove along the middle, and in which sometimes even a separation may be perceived.

When the silk-worm is near the time of change to the pupa,

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pupa, the reservoirs of silk are full, and it is pressed by its sensations to relieve itself from this incumbrance. Having made choice of a convenient situation, the operation of spinning commences. At first it throws out some loose thread, which serves to support the future superstructure: upon these it forms an oval of a loose texture, consisting of what is called flos silk; and within this it forms a firm and more consistent ball of silk. It is now inclosed within the circumference of the spheroid, the interior of which is the scene of its further operations: in this it is seen resting on its hinder parts, and with its mouth and fore legs directing and fastening the threads. These threads are not directed in a regular circular form, but are spun in different spots, in an infinite number of zig-zag lines; so that, when wound off, it proceeds in a very irregular manner. This thread, when measured, has been found to be about three hundred yards long, and so fine that eight or ten are generally rolled off into one by the manufacturer. The silk-worm usually employs about three days in finishing this cone; the inside is generally smeared with a kind of gum, which is designed to keep out the rain. It next assumes the pupa form, in which it remains from fifteen to thirty days, in different climates, before the moth is produced. When the insect intends breaking from the cocoon, it moistens one end of the cone, and by frequent motions of the head loosens the texture of the silk, so as to form a hole without breaking it. See *SILK-WORM, Phalana Mori*.

From a series of experiments made by Reaumur on the silk of this insect and that of the spider, in order to ascertain their comparative excellence, it was found that the thread would bear the weight of thirty-six grains, while that of the spider could not sustain twelve grains, breaking under its weight. There are silks spun by other insects, with which we are little acquainted, that in point of strength far exceeds that of the common silk-worm. The popular opinion, that the silk worn in different parts of the world is the sole produce of this species (*phal. mori*), is erroneous. This kind of silk is generally esteemed for its peculiar beauty and delicacy of texture. There are others less costly, which, from their superior strength, are better adapted to common wear, and are for this reason in more general use in some parts of the globe. The silk obtained from the cocoons of the two species of *bombyces paphia* and *cynthia* are of this kind, as appears from an interesting paper on these insects by Dr. Roxborough, F.L.S., inserted in the seventh volume of the Transactions of the Linnæan Society.

These insects bear the names of tuffeh and arrindy silk-worms in India: both exceed the common silk-worm in size, the first especially, which is one of the largest of the attaci family of bombyies, and the silk of which appears to be more valuable than that of the other kind.

The tuffeh silk-worm is found in such abundance over many parts of Bengal, and the adjoining provinces, as to have afforded the natives from time immemorial an ample supply of a most durable coarse silk, commonly called tuffeh silk, which is woven into a kind of cloth called tuffeh doot'ries, much worn by the Bramins, and other sects of Hindoos. This substance would no doubt be highly useful to the inhabitants of many parts of America, and the south of Europe, where a cheap, light, cool, and durable dress, such as this silk makes, is much wanted. The caterpillar, when full grown, is about four inches in length, and bulky in proportion; its colour green, with a lateral stripe of yellow edged with red. The plate in which the caterpillar is represented, if we mistake not, is engraven from a drawing executed by an Indian artist, and must be received with

some allowance for inaccuracy; but from this we may collect that it has a single series of yellow oval dots beneath the lateral line, (amounting to six or seven in number,) which are perhaps its spiracles; and these, in the description, are denominated specks of gold colour. When these are ready to spin, each connects, by means of the recent glutinous filament of which the case is made, two or three leaves of the jujube tree, the vegetable on which they feed. These connected leaves form an exterior envelope, which serves as a basis to spin the complete case or cocoon in; and "besides this," says the writer, "the case is suspended from a strong branch of the tree in a wonderful manner by a thick, strong, consolidated cord, spun of the same materials from the bowels of the animal." It remains nine months in the pupa state. The insect, when produced, expands to the breadth of five or six inches, and those of the female to eight inches.

There is another kind of wild silk-worm produced in the Burbhoom hills, which is said to be more capable of being domesticated; and a fourth sort, a supposed variety of the tuffeh-worm, in the hills near Bauglipore, the cocoon of which is smaller than that of either of the two first mentioned.

The arrindy silk-worm still remains to be noticed. This is of a species altogether different from the former, and is the *bombyx cynthia* of entomologists. This insect, known to the Hindoos by the name of arrindy in some parts, and in others arrundi, appears to be peculiar to the interior parts of Bengal; and it is presumed, may be even confined to the two districts Dinagepore and Rungpore, where the natives breed and rear it in a domestic state, as they do the common silk-worm. The food of the caterpillar consists entirely of the leaves of the common ricinus or palma chrilli, which plant is cultivated abundantly over every part of India, on account of the oil obtained from the seed. The Hindoos call this plant arrindy, and hence is derived the name of the insect. The caterpillar, when full fed, is about three inches long; the colour pale green; and each segment verticillated with a few conic tubercles disposed in a single line. The cocoon is white or yellowish, of a very soft and delicate texture, about two inches long, and three in circumference, and pointed at each end. There is a wide distinction between this species and *B. paphia*, in the period it remains in the pupa form; this requiring at the utmost not above twenty days, instead of nine months, to complete its last transformation.

The filaments of which the cocoon is composed are so exceedingly delicate, that it is said to be impracticable to wind off the silk: it is therefore spun like cotton. The cotton, thus manufactured, is wove into a coarse kind of white cloth, of a seemingly loose texture, but of incredible durability; the life of one person being seldom sufficient to wear out a garment made of it, so that the piece descends from mother to daughter. Some of the Indians, however, have a method of spinning the silk of this species, and the process is related as follows. Four or five of the cocoons are fastened to a piece of wood, with something heavy to make it spin round, while suspended by the thread. When they let out a sufficient quantity of the cocoons from their hand, it is twisted by this piece of wood spinning round; and when well twisted, it is wound round the wood, and another length let out of the hand. The cocoons are spun wet, but only with cold water. The cloth is woven in small pieces in a loom: its uses are for clothing for both men and women; it will constantly wear ten, fifteen, or twenty years. This silk must be always washed in cold water; for if put into boiling water, it will tear like old rotten cloth. Some manufacturers

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manufacturers seem to be of opinion that shawls, and other silken articles of dress, equal in quality to any manufactured in India, could be fabricated with this material. There is reason to apprehend that this silk is highly valued in India; nor can we entertain the least distrust of its want of durability, since it is well known that the coverings of their palanquins are of this particular kind of silk.

On further investigation and research into the history of the larger species of the bombyx tribe, we are persuaded others will be found to form cocoons or pupa spinings, which, with proper attention and culture, may hereafter be productive of similar advantages. We are not ignorant that in other parts of Asia, and in America, there are many species that spin in the same manner an envelope round the pupa; and some of these at least, we must suppose, capable of producing a silk of beauty and durability equal to some of those in present use. We should not be surprised to learn that bombyx atlas, the most considerable in magnitude of all the moth tribe, is expressly reared in China for the sake of its silk. We suspect this to be the truth. It would be desirable also to ascertain whether the cocoons of the species hesperus, cecropia, cytherea, promothea, and some others, could not be beneficially employed in the production of silk. Mr. Abbot, in his *Insects of North America*, speaks generally of some attempts being made to fabricate the silk of one or two of the larger moths of that country; the cloth prepared from which is represented as strong and durable; but he expresses doubt how far the experiment might be useful, as the insects which produce the silk are not abundant. This objection might easily, we should imagine, be obviated by cultivation: insects are highly prolific, and if they could be reared in what may be termed a domesticated state, could be produced in any numbers.

Among a variety of other curious information which this paper conveys, the following circumstances appear so amusing, and seem to reflect such new light on the history of these useful insects, that we cannot refrain repeating them. The cocoons of this insect, bombyx paphia, feed on the leaves of a plant called byer by the Hindoos (*rhamnus jujuba*), and likewise on the plant they call asseen (*terminalia alta glabra* of Roxb.). They are annual, remaining nine months in the pupa state, and three months in that of the egg and caterpillar. The species cannot be domesticated, nor can the natives even retain any for feed. The hill people say, they go into jungles, and under the byer and asseen trees they find the excrement of the insect; on which they examine the tree, and, on discovering the small worms, they cut off branches of the tree sufficient for their purpose, with the young brood on the branches. These they carry to convenient situations near their houses, and distribute the branches on the asseen tree, in proportion to the size of them; but they put none on the byer tree. The Parieahs, or hill people, guard the insects night and day, while in the worm state, to preserve them from the crows and other birds by day, and from bats by night. As soon as the moth pierces the cases, it escapes; nor do the people prevent this, as they have learnt by experience that it cannot be kept alive more than a few days, and that retaining it would not be attended with any advantage.

To wind off these cocoons, the natives put them into a ley made of plantain ashes and water for about two hours; after which they take them out of the ley, and put them in their wet state into an earthen pot: those which are properly softened are first applied to the reel, and so on as the cocoons become soft, for four or five days, till the whole

are wound off. The implement used for taking off the thread is a small common reel of four bars. The cocoons are laid in a smooth earthen dish without water; the reel is turned by the right hand, whilst the thread of four or five cocoons passes over the left thigh of the spinner, and he gives the thread a twist with his left hand upon his thigh. The thread is exceedingly apt to come off double and treble for several yards together, which is not regarded by the natives, as breaking off double threads would diminish the produce, and moreover would occasion loss of time: a very even thread, however, with care may be reeled off. The bughy silk-worm feeds indifferently on byer or asseen leaves.

The jarroo cocoon is the pupa spinning of an insect closely allied to the preceding, but whether a distinct species or variety, from the knowledge we at present possess, seems difficult to determine. These are called the jarroo cocoon, from being produced in January, the coldest month of the year; and the natives affirm, that they are different from the bughy. The jarroo will eat the byer leaf, if it cannot get the asseen; but will always prefer the latter, and will produce better cocoons when fed on it. The silk is duller in colour. The natives are able to retain part of the jarroo cocoons for feed. These they hang out on the asseen trees, when the proper season of the moth arrives. The males, when hatched, invariably fly away; but the females remain on the trees. These are not impregnated by the males bred along with them, but in ten or twelve hours, or perhaps two or three days, a flight of males arrive, settle on the branches, and impregnate the females; and it is worthy of remark, that the hill people consider it good or ill fortune, in proportion to the speedy or tardy arrival of these male visitors. The purposes of nature accomplished, the males expire, and the females live only long enough to deposit the eggs in safety on the branches of the trees. These males are supposed by the natives to come from a vast distance: it is affirmed even, that by marking the wings of a number of males, previously to letting them fly, their progress in quest of the females has been traced to the distance of one hundred miles and upwards. This, though remarkable, is not more extraordinary or unworthy of credit than the circumstance (if truly stated), that the males and females of the same brood never associate together in any manner, when they enter the fly state; the males regularly flying off in search of another brood of females, and leaving those of their own family to the embraces of another flight of males.

There is a caterpillar which forms its silken cone in the shape of a boat turned bottom upwards, whence it is called by Reaumur "coque en bateau." It consists of two principal parts, each of which is framed by itself, and formed of an innumerable quantity of minute silk rings; in the fore part there is a projection, in which a small crevice may be perceived, which serves when opened for the escape of the moth; the sides are framed with so much art, that they open and shut as if framed with springs; so that the cone from which the fly has escaped appears as close as that which is still inhabited.

Those caterpillars which do not spin a cone supply that want with various materials, which they form into a habitation to secure them from injury while in the pupa state: some form a covering with leaves and branches tied or made fast together, others connect the leaves with great regularity; many strip themselves of their hairs and form a mixture of hair and silk, others construct a cone of sand or earth, cementing the particles together with a kind of glue:

some gnaw the wood into powder, or like saw-dust, and cement it together; and others make cases in holes, which they form in the trunks of trees.

The period of their change into the chrysalis or pupa state is very regular in most insects, unless in seasons peculiarly unfavourable. Some change in May, others in June, July, August, and September, and the time of emerging from the state of pupa is fixed with no less precision. This is a fact well known to every practical entomologist. Some remain in the pupa state only twelve or fifteen days, others twenty or thirty, and these are chiefly of the butterfly tribe. Those of the moth kind are commonly much longer, some remaining in this state only two or three months, others six, nine, or twelve, some two years, and others even it is known so long as three years. Lyonet has remarked, that the periods of change to the chrysalis state is not so constant, but that a degree more or less will affect it. The same insect, he says, which in the middle of summer would have acquired its utmost size in less than three weeks, will require as many months, and even much more if it comes forth at the end of the season. And again, he observes, that such a nymph or chrysalis which in summer will change into a winged insect in fifteen days, will employ sometimes six, seven, or eight months for the same purpose, merely from having gone into the chrysalis state a few days later than those which have changed so rapidly. That particular incidents may occasionally justify these remarks of Lyonet, we shall not dispute, but this can be only understood of insects hatched in seasons of unusual inclemency, or under circumstances in the highest possible degree uncongenial to their transformations. Irregularities will arise from this cause. In general, however, the appearance of every species (whose history is once correctly ascertained) whether in the larva, pupa, or winged state, may be determined by the time of the year. Most insects perform all their changes within the course of twelve months, and are found in their several states at particular periods annually; others have two broods in the course of that time, and consequently appear in the same state at two different periods of the year.

*Neuroptera*.—Some of this order are semi-nymphs, as the libellulæ and ephemeræ, in which the rudiments or half-wings are developed, and which eat and pursue the same manners of life as the larva. Others are like the nymphs of the coleopterous order in appearance, and lie dormant in the ground, generally in cases constructed of extraneous materials. The myrmelion forms a hollow ball of sand for this purpose.

*Hymenoptera*.—In the pupa of the cynips the limbs are partially disclosed in its external figure, and it remains in the central cavity of the gall in which it lives during the state of larva, while in the pupa form. The tentredo forms a kind of exterior case or envelopement, within which it assumes the pupa form, and which in some kinds resembles the texture of thin parchment. The pupa of the firex is quiescent, and is usually found lodged in timber: this has the limbs distinctly formed. The pupæ of the ichneumons are inclosed in oblong silken cones. Those of the wasps and bees are well known. In the ants the limbs are distinct.

*Diptera*.—The pupæ of the tipulæ are usually cylindrical like the larva, and quiescent; many of the muscæ appear of an elongated egg shape, without any segmental divisions, and totally devoid of motion. The pupa of the culex is curiously incurvated and ovate, with respiratory tubes, through which it breathes; it is an inhabitant of the waters. The egg of the hippoboscæ serves in lieu of a pupa, or in other terms the hippoboscæ are oviparous, and have no pupa.

*Aptera*.—As the individuals of this order are produced with few exceptions in the perfect form from the egg, they have no pupa, at least the common flea is the only instance to the contrary; this undergoes the usual transformations from the egg to the perfect state; its pupa resembles that of some coleopterous insects when magnified.

*Imago*: the final or perfect state which all insects assume after passing through the successive changes from the egg, the larva, and pupa form; which latter it quits in the imago state. This might, with more simplicity, be termed the winged state, were it not that some insects, after quitting the pupa, are apterous, or without wings. In the imago form the insect is in every respect perfect in all its parts, and possessed of every function which nature has intended the species to enjoy.

#### *Habitation of Insects.*

Insects are of two kinds, aquatic and terrestrial, and their habitation must be considered separately.

Some live only in watery places, appearing occasionally on the surface of that element, and which very rarely plunge themselves in, or if they fall in, either rise again immediately to the surface or perish. Others live only in water, and cannot subsist out of it. Many, after having lived in the water while in the larva and pupa state, come out afterwards with wings, and become entirely terrestrial. Some undergo all their transformations in the water, and then become amphibious. Others again are born and grow in the water, but remain during the pupa state on dry land, and after they attain their perfect form live equally in air and water. There are, lastly, some who live at the same time occasionally both in the water and on land, and which, after their transformation, cease to be aquatic.

Among the insects which remain on the superficies of the water, are some spiders which run with great address and agility, without moistening their feet or their body. There are aquatic cimices which swim or rather run on the water with great velocity, and by troops, as may be often seen on the surface of still water. Some walk slowly on the surface. The gyrinus moves swiftly and in circles. The nepæ are of that kind which live only in the water, and cannot subsist out of it, or at least can remain out of it only a short time. The number of those which, after having lived in the water, leave it when in a winged state is very great: among these are the libellula, the ephemera, the phryganea, culex, tipula, and some other species of muscæ; all these are of the aquatic kind, both in the larva and pupa state, but when they have assumed their perfect form are entirely terrestrial, and would be drowned therein. The kinds most strictly amphibious are the water beetles, such as the dytiscus and hydrophilus; these remain in the water all day, but towards evening come upon the ground and fly about, plunging themselves again into the water at the approach of sun-rise: the larvæ of these insects are entirely aquatic; but when the time of their pupa state arrives they descend into the earth, where they make a spherical case, thus becoming entirely terrestrial, and in the perfect state are amphibious.

Most insects of these tribes prefer stagnant waters, others those of a purer nature, and we have instances of certain insects which inhabit, with perfect convenience, springs of a warm and mineral nature. At the baths of Abano, in the Venetian states, is a spring of this description, impregnated with sulphur, in which small water beetles are seen swimming about, and which die on being taken out and plunged into cold water.

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Many insects that live under the surface of the earth in the perfect state crawl out occasionally, as the mole cricket, and some of the aptera, as the julus and scolopendra; these are generally found in the earth under stones, or beneath rotten wood in damp situations. Some insects remain underground part of their life, but quit that situation after their change, as in the coleoptera. A vast number of others live in animal substances of every kind. The habitation of some, as the myrmecoleonformicarius, is curiously constructed in the sands.

There is a species of spider found in Jamaica (*aranea venatoria*) which burrows in the earth like a rabbit; it is of a size very far surpassing the largest of the European spiders, and is not uncommon there. This creature forms a hole twelve or fifteen inches deep, of a cylindrical shape, rather more than an inch in diameter, and which it lines with a thick coat to prevent the earth from tumbling in. The aperture is closed with a kind of lid or door attached by a single hinge, and which open outwardly, falling down and shutting the aperture by its own gravity. Into this the spider retires with its prey, and devours it in safety, as few insects can penetrate into its cell. These nests or cases form a complete habitation, should the sands in which they are constructed give way.

Insects of the lepidopterous order are very rarely carnivorous; there are instances of this, but these are uncommon. Their food and that of many other insects are of the vegetable kind, and their habitations are trees and plants. The oak and the willow among trees, and numbers of different plants among herbage, are the natural habitation of insects in great abundance. Some live in the roots, others in the wood; in the leaves, and in galls formed therein; in flowers; in fruit; and in grain. Some caterpillars form a kind of hammock, in which they eat and go through their various changes; while others construct a tent, under which they live till they have consumed the surrounding herbs, when they leave their abodes and pitch their tents in another spot, where they can find abundance.

Many insects associate together all their lives, others only for a certain period. Those who live together proceed from the same moth who deposited the eggs near each other, or laid them in a heap, and thus formed a kind of nest. These are generally hatched about the same time, and live together, forming a kind of republic. These societies include two, three, or four hundred individuals, and usually live inclosed in a large web, like the lackey moth, (*phal. neustria*) and the ermine moth. Of these social caterpillars there are some kinds which never quit the society to which they belong, but pass into the pupa form in the same nest. One of the most remarkable of these caterpillar communities is that of the bombyx processionea. These live on the oak separate till they arrive at a certain age, when they associate together, and do not quit their society till they acquire their perfect form. As the number of the caterpillars thus assembled is considerable, the nest is also very large. They remain in their habitation till sun set. When they go out one of the body precedes the rest as a chief, whom they regularly follow. When the leader stops the rest do the same, and wait till it goes on again before they recommence their march. The first file generally consists of a single caterpillar, which series is succeeded by a double file, these by three in a row, which are then followed by files of five, and so on. They keep close to each other, not leaving any interval either between the ranks or between those in each rank, all following their captain in compact order, whether in a straight or irregular course. After they have taken their repast they return to the nest

in the same order as they set out. This conduct is regularly pursued till they are full grown, when each spins a cone for itself in the nest. It has been remarked, that though these caterpillars proceed often very far from the nest, it is by no means difficult for them to get back again, because they spin a thread in their route. The first leads the way, the second follows spinning, the third spins after the second, and soon forming thus a path of threads.

Upon the same tree, shrub, or plant, we often find numbers of caterpillars which have no affinity to each other, and of which the actions of one have no influence over the manners of the other; they may in this respect be considered solitary. There are others who seem still more independent of each other even than these, because they shun all intercourse, constructing lodgments formed of leaves tied together with considerable ingenuity, in which they live as in an hermitage. The operation by which these caterpillars tie the leaves together is far surpassed by another kind, who fold and bend one part of the leaf till it meets the other. These are again excelled by those who roll the leaves which they inhabit. For this purpose the caterpillar makes choice of part of a leaf which it finds in some degree bent; here its work commences, the caterpillar moving the head with great velocity in a curved line, or rather vibrating it like a pendulum, the middle of the body being the centre on which it moves. At each motion of the head a thread is spun and fixed at that part to which the head seems to be applied. The threads are extended from the bent to the flat part of the leaf, and the curvature which is to be given to it. There is another species of which it is observed, that at each new thread it spun, the edges of the leaf insensibly approached to each other, and were bent more and more, in proportion as the caterpillar spun new threads; when the last thread was spun, that which preceded it was loose and floating in the air. To effect this the caterpillar, after it has fixed a thread to the two edges of the leaf, and before it spins another, draws it towards itself by the hooks of its feet, and by this means bends the leaf; it then spins another leaf to maintain the leaf in this position, which it again pulls towards itself, and repeats the operation till it has bent the leaf in its whole direction. It now begins again placing the threads further back, upon the bent part of the leaf, and by proceeding in this manner it is rolled up; when it has finished this business it strengthens the work by fastening the ends of the leaf together. The habitations thus formed are open at both ends, and within which the insect feeds in safety. At the approach towards the pupa state, the caterpillar lines the rolled leaf with silk, that the rougher parts may not injure it.

A great number of the smaller larvæ require an artificial covering to protect them. Some inhabit the interior part of leaves in which they form large oval or circular spaces; others form a kind of gallery within, which in some is straight, in others crooked. Many of the tineæ are found lodged in cylindrical tubes or cases, which they form of different substances closely woven with fine silken threads. The small caterpillar found in neglected woollens and other similar articles is of this kind, living in a cylindrical case, and producing a small moth.

The phryganea larvæ construct cases somewhat similar in form, and which are also open at both ends; in these the larvæ reside, the outside is formed of different substances, such as bits of reed, stone, gravel, and small shells, which they arrange and manage with singular dexterity. When they walk they only advance a few of the anterior rings of the body, training the case after them. When they are

about

about to assume the pupa form they close up the ends with silken threads.

But the habitations of these insects, though constructed with ingenuity, are in no manner comparable with the architectural fabrications of many other insects, as those of the wasp, the bee, the common ant- (*formica*), the white ant (*termes*), &c. The structure of the nests constructed by the common wasp, and the common honey bee, cannot be unknown to any reader. Among the habitations of the solitary, or those called the wild bees, there are many which deserve remark. Some of the bee tribe penetrate into the earth, where they form small contiguous cavities, in each of which they deposit an egg, with a sufficient quantity of provisions for the sustenance of the larva. There is one kind whose nest consists of several cells artfully let into each other, but not covered with a common inclosure; each cell consists of two or three membranes, inexpressibly fine, and placed over each other. The cavity in which the nest is placed is smeared over with a layer of matter, like that of which the cells are formed, and apparently similar to that viscous humour which snails spread in their passage from one place to another. An egg is deposited at the bottom of each cell, where, after it is hatched, the grub finds itself in the midst of a plentiful stock of provision, for in each cell there is placed a quantity of paste, or a kind of wax, which is to serve as food for the worm, and as support to the wall of the cell.

Another species that forms its nest under ground makes a perpendicular hole in the earth about three inches deep and cylindrical, till it comes within three-fourths of an inch of the bottom, when it begins to open wider. The suitable proportions being given, the bee proceeds to line with tapestry not only the whole of the inside, but also the entrance; the substance with which it is lined is of a crimson colour, and appears as very beautiful. This lining is formed of fragments of the flowers of the poppy, which the bee cuts out curiously, and then seizing them with her legs conveys them to her nest. If these pieces are rumpled, she presses them smooth, and then affixes to the walls of her cell; or if the piece she has cut and transported is found too large, she clips off the superfluous parts, and conveys the shreds out of the apartment. After the bee has lined the cell, she fills it nearly half an inch deep with a kind of paste, proper to nourish the larva when hatched from the egg. When the bee has amassed a sufficient quantity of paste, she folds the tapestry over the paste and the egg, which is by this means inclosed as it were in a bag of paste; and the bee then fills up with earth the empty space that is above the bag. Another of the bee tribe is said to construct its nest in the same way, with this difference only, that the lining is of the corolla of the rose.

The carpenter bee (*apis centuncularis*) constructs her nest in pieces of wood, whence the name; in this she perforates long cylindrical hollows, which she divides into stages, and deposits her eggs, each inclosed in a curious cylindrical case formed of leaves, not quite an inch in length, and less than half an inch in diameter, and these are disposed endwise one above another to the amount of ten, twenty, or more, the cylindrical perforation in the wood being two or three feet long, or sometimes more. They bore the wood most commonly in the longitudinal direction of its ligneous fibres, but this is not always the case. There are several species of this order in appearance much like each other. The leaves which form the lining of the cases in one species is that of the rose.

The former are called the carpenter bees on account of

the holes which they bore in the wood; there is another which bears the name of mason bee, from the peculiar structure of the nest. Their manner of building is this: the bees collect with their jaws small parcels of earth and sand, which they glue together with a strong cement, which is furnished from the proboscis; and of this they form a simple but commodious habitation, which is generally placed along walls that are exposed to the south. Each nest resembles a lump of rude earth of about six or seven inches diameter, thrown against the wall; the labour of constructing an edifice of such magnitude must be considerable, as the bee can only carry a few grains at a time. The exterior form is rude and irregular, but the art exhibited within more than compensates for the ruggedness of the external appearance. The interior is divided into twelve or fifteen cells, separated from each other by a thick wall; in each of these an egg is deposited by the parent bee. The cells are constructed progressively, for when one is finished she places an egg in it, with a sufficient quantity of honey to nourish the larva; she then builds another, and so proceeds till all her eggs are deposited. When the young are hatched the strength of their jaws enable them to penetrate through their cells with perfect ease.

There is a species of spheg called the ichneumon wasp, whose manner of constructing the nest is still different from either of those before mentioned. This little creature generally begins its work in May, and continues its labours through the greater part of June. The object of her labour seems at first to be the digging of a hole a few inches deep in the ground, in the construction of which she forms however a hollow tube above ground, the base of which is the opening of the hole, and which it raises as high above ground as the hole is deep below; it is formed with great care, resembling a coarse kind of sillagree work, consisting of the sand drawn from the hole. The sand out of which she excavates her cell is nearly as hard as a common stone. This it readily softens with a penetrating liquor, with which she is well provided; a drop or two of it is imbibed immediately by the sand on which it falls, which is instantly rendered so soft, that she can separate and knead it with her jaws and fore feet, forming it into a small ball, which she places on the edge of the hole as the foundation stone of the pillar she is about to erect; the whole of it is formed of such balls, ranged circularly, and then placed one above the other. She leaves her work at intervals, probably in order to renew her stock of that liquor which is so necessary for her operations; these intervals are of short duration; she soon returns to her work, and labours with so much activity and ardour, that in a few hours she will dig a hole two or three inches deep, and raise a hollow pillar two inches high. After the column has been raised to a certain height perpendicularly from the hole, it begins to curve a little, which curvature increases till it is finished, though the cylindrical form is preserved. She constructs several of these holes, all of the same form and for the same purpose. It is evident the hole was dug in the ground to receive the egg, but the purpose of the tube of sand is not very apparent. By attending to the labours of the wasp, one end, however, may be discovered; it will be found to serve the purpose of a scaffold, and that the balls are as useful to the wasp as materials to the builder, and are therefore placed as much within her reach as possible. She uses it to stop and fill up the hole after she has deposited an egg in the cell, so that the pillar is then destroyed, and not the least remains left in the nest. The parent insect generally leaves ten or twelve worms as provisions for the young larva.

In all these fabrications there is a degree of ingenuity in design, and exactness of execution, which, independently of the labour required in their construction, excites our admiration. The talent, if it may be so expressed, of the insect race, is more obviously displayed in the formation of the dwellings than in most other particulars of their history. It is a pleasing subject of inquiry, and extremely worthy of attention, but for an elementary discourse we have, perhaps, already pursued these observations to a due extent, and shall therefore conclude with a concise account of one other, which, from its stupendous dimensions, the order, regularity, and beauty of its architectural design, and inimitable convenience to the purposes for which it is intended, cannot fail to excite the astonishment of every observer; it may be anticipated that the allusion is to the buildings of the termites. These diminutive insects, known more generally by the name of the white ants, though, technically speaking, they are entirely of a distinct genus, are natives of the East Indies, Africa, and the southern parts of America. They live in societies, each of which is composed of some thousand individuals, all of whom are accommodated in the same habitation. Their structures are of a pyramidal form, rising to the height of ten or twelve feet, and covering no inconsiderable extent of ground at the base. They usually build in the plains several contiguous to each other, and from their size and form may sometimes be mistaken at a distance for the huts of the natives.

These nests are so common all over the island of Bannanas, and the adjacent continent of Africa, that it is scarcely possible to stand on an open place where one of these buildings is not to be seen. The domes are so strong that they will easily bear the weight of three or four men standing on them at once, and shelter the interior from every attack of the weather. The interior is divided with the utmost regularity into an immense number of apartments, arched chambers, magazines, and avenues leading to them; and the centre, on a level with the ground, contains the royal apartment, in which the queen resides, surrounded by the nursery, &c. The white ant is the *termes fatale*: there are two, if not more, species besides, namely, *destructor* and *arda*, both inhabitants of Africa, which build nests of a similar form, but of much smaller size. See the article *TERMES*.

*Food of Insects.*

Insects feed on all kinds of vegetable and animal substances. There is scarcely any production of these two kingdoms which does not serve for food to some kinds of insects. They may therefore be considered under two heads; those which live on vegetables alone, and those supported chiefly on animal food. The organs of the mouth point out the very wide distinction nature intended in this respect, some being adapted to the purposes of mastication, others to that of suction only; some, like ruminating animals, have two stomachs, others only one; the alimentary canal in some is short, in others long, and upon the whole, their internal conformation, as well as external form, presents the most striking differences, each being in a peculiar manner adapted to the nature of the food upon which the animal subsists.

There is yet another circumstance well worthy of remark; in all those insects which undergo material change, the transformation of their external figure is accompanied with an entire revolution in their internal structure and economy; the larvæ destined to feed on vegetables, or the grub on carrion, after effecting their transformation, present no longer the same appearance within; parts adapted to their former mode of life, and inapplicable to their present one, totally

disappear, and other organs, either before not existent, or which remained concealed, are now developed. The stomach of the butterfly, when in the larva state, is adapted to the reception and digestion of its vegetable food, as its organs of mastication are to its previous preparation; but this stomach and this mouth both disappear in the butterfly, and other organs make their appearance; its mode of life is totally changed; it derives its sustenance from the nectar of flowers, and its whole conformation is adapted to its new mode of life. These arguments are not inferred from a few solitary instances; they are exemplified in numberless examples: nothing is more common than to find the larvæ subsisting on food altogether different from that which supports the same insect in the winged state.

Among those numerous tribes which feed on vegetables, some sink into the earth, where they feed on the roots of grass, and do considerable injury to gardens. The food of others is dry and hard; they pierce the wood, reduce it to powder, and then feed on it: in this manner many of the *cerambyx* tribe and other *coleoptera* feed in the larva state. Some attack the leaves, eating the whole substance, except the principal nerves; while others feed only on the parenchymous parts which are contained between its superficial membranes, forming paths and galleries within. These insects are not always content with the leaf; some eat the flowers, and even this food is too gross for many; the bee, the butterfly, the musca, and a host of others, feed only on the nectareous juices, or the farina which they collect from flowers, or the delicious fluids of fruits. Corn and other grain are not free from them; they divide the produce with us, or often deprive us of large quantities. They insinuate their larvæ into the most tender parts, and each oftentimes destroys more than would be sufficient to feed fifty of them. We frequently find the larvæ of some insects in pears, plumbs, peaches, and other fruit. There, indeed, appears scarcely any part of a plant which does not serve as food to different insects; each has its appropriate food, and though the parent animal does not, perhaps, subsist on the same vegetable, yet she instinctively deposits her eggs on that particular shrub or plant which will be food for her young: Some more voracious than the rest feed upon all with equal avidity; the migratory locust, *gryllus migratorius*, is a striking example of this. The ravages of this insect have been at particular times so extensive as to lay waste the vegetation of whole districts, of even kingdoms; an instance is mentioned in the *Amœnitates Academicæ*, in which they overran all Sweden, and devoured all the plants, inasmuch that cattle perished with hunger, and men were forced to abandon their country, and fly to the neighbouring regions. Similar results have arisen from the ravages of locusts in various parts of the world at various periods, as appears from the most credible historians. The sacred writings are not silent on this subject. In the year 593 of the Christian era these animals appeared in such vast numbers, as to cause a famine in many countries. Syria and Mesopotamia were over-run by them in 677. In 852 immense swarms took their flight from the eastern regions into the west, and destroyed all vegetables, not even sparing the bark of trees, and the thatch of the houses, after devouring the crops of corn, grass, &c. Their daily marches were observed to be about twenty miles each, and it is said their progress was directed with so much order, that there were regular leaders among them, who flew first and settled on the spot which was to be visited at the same hour the next day by the whole legion; their marches were always undertaken at sun-rise. In 1541 incredible hosts afflicted Poland, Wallachia, and all the adjoining territories, darkening the sun with their num-

bers, and ravaging all the fruits of the earth. The years 1747 and 1748 afforded a memorable instance of the ravages of these animals in Germany and other parts of Europe, as far north as England. In the eastern parts of the world such flights of locusts appear more frequently than in Europe, and it is often found necessary for the governors of particular provinces to command a certain number of the military to take the field against armies of locusts with a train of artillery.

The far greater number of insects feed, however, more discriminately; some are confined to one particular plant, and others only to two or three kinds; and neither in many cases will eat any other food; they often perish in the midst of abundant vegetation, because they cannot procure that kind which is their natural food. The quantity of food which a caterpillar will devour is astonishing; that which feeds upon the cabbage (*papilio brassicæ*) destroys in twenty-four hours more than twice its weight. If larger animals required a proportionable quantity of food, the earth would not be able to nourish its inhabitants. It should, however, be remembered, that it is only during one period of their lives that they are so voracious, or subsist on such food; after they quit the larva form they are nourished in a different manner.

A vast number of insects reject vegetables in the larva state, and live only on animal food; some seeking that which is beginning to putrefy, while others delight in that which is entirely putrid, or on the dung of animals. Some attack and feed on man himself, while others are nourished by his victuals, clothes, furniture, and habitation; and again others prey on his cattle. No animal whatever is exempt from these depredators. Some subsist on the blood and humours of quadrupeds, others of birds, and a great proportion of them prey on insects of other kinds, or often attack their own, and thus perpetuate an endless war among each other.

Every larger animal has its appropriate lice, which feed on and infest it: these in size or voracity bear no regular proportion to the animal they subsist upon. Those of man are diminutive in the extreme, compared with those which torment some animals. The hippoboscæ and the tick, though not in technical terms the lice of the animals they infest, have the same habits, and draw nourishment from the body in the same manner; and these, in comparative bulk with the victims of their depredation, are an hundred, nay even, in some instances, a thousand times larger than these uncleanly vermin in man. Some are not content with the blood and juices which they suck from animals; they seek their food in the flesh, and that while full of life and health. The oestri, or gad-flies, are familiar examples of this, the larva feeds upon the flesh beneath the skin in cattle. The parent lodges its eggs in the flesh by making a number of little wounds, in each of which it deposits eggs, so that every wound becomes a nest, and the eggs are hatched by the heat of the animal. Here the larva finds abundance of food, and is at the same time protected from the changes of the weather, and they undergo their transformations in security. The parts they inhabit are often discovered by a lump or tumour which they occasion; this suppurates, and is filled with matter, in which the head of the larva is always found plunged. When the time of change arrives the larva drops out, and seeks a convenient place in the ground, where it passes to the pupa state. The ravages of the larva hatched from the ichneumon eggs, in the body of the caterpillar, are still more destructive, as they entirely destroy the vitals of their victims. The number of insects which are of a carnivorous disposition is very great; and it

is among these we find the traces of the greatest art and cunning, as well for attack as defence. Every one is acquainted with the dextrous arts of the spider, to seize his prey, the curious nest he spins, and the central position he assumes in order to watch more effectually the least motion communicated to its tender threads when the incautious insects settle upon it. D.

ENTONNER, *Fr.* in *Roman Catholic Churches*, is announcing to the choir the tone or sound with the organ, or the voice of the officiating priest, with which a chant, hymn, psalm, or anthem is to begin. In our cathedrals this is done for the responses by a canon, vicar choral, or by a single note on the organ.

ENTORSIS; in the *Manege*. See PASTERNA.

ENTOYER, or ENTOIRE, in *Heraldry*, is used to express a bordure, charged entirely with things without life. See BORDURE.

ENTRACQUE, in *Geography*, a town of Italy, in the principality of Piedmont, on the Gesso; 5 miles S.S.E. of Demont.

ENTRACTE, *Fr.* the space of time which elapses between the end of one act of a drama and the beginning of another; and during which the representation is suspended, while the action is supposed to be advancing elsewhere. The orchestra fills up this space by performing a symphony, which supplies the place of what used, in England, to be called an *ad-tune*.

It does not appear that the Greeks ever divided their dramas into acts; consequently, they had no act-tunes. The representation was never suspended on their stage empty from the beginning of the piece to the end.

The Romans, less interested in these exhibitions than the Greeks, were the first who divided their pieces into several distinct parts, the intervals of which afforded a relaxation to the attention of the spectators; and this custom has been continued elsewhere ever since.

But as the entract was intended to suspend the attention, and give some repose to the mind of the audience, the stage should have remained vacant. But the interludes with which the vacuity was formerly filled furnished an interruption in a very bad taste, which infallibly injures the piece in breaking the thread of the action.

However, Moliere himself did not see so simple and obvious a truth; the spaces between the acts of his last pieces were filled with interludes.

The French, whose public spectacles have more reason than enthusiasm in them, and who dread being long kept in silence, have since reduced their interacts to their due simplicity, and it is to be wished for the perfection of the drama that they were imitated, in that particular, every where else.

The Italians, whom an exquisite sensibility often guides better than reason, have proscribed the dance of the dramatic action (see OPERA); but by an inconsistency arising from the too long duration which they allow to their representations, they fill their interacts with ballets, which banish them from the piece, in representation, and if they avoid the absurdity of a double imitation, they give into an equal absurdity by a transposition of scene, and by harassing the spectator from object to object, they make him forget the principal action, lose the interest, and, in order to give pleasure to his eyes, rob him of those of the heart.

They began, however, to feel (in 1768) the defect of this monstrous assemblage; and after having already almost driven intermezzi from their stage, they will doubtless ere long, get rid of the dance, reserving it only as a brilliant and detached spectacle at the end of the grand piece.

But though the stage remains vacant during the intera<sup>c</sup>t, it is not to be understood that the music ought to be silenced; for at the opera, where it constitutes the principal existence of every thing, the sense of hearing ought to be so connected with that of sight, that as long as the stage is seen the harmony should be heard, which is supposed inseparable from it; so that its concurrence may not appear afterwards foreign or new, but united with the melody of the vocal performers. Chiefly from Rousseau.

The difficulty which presents itself on this subject, is to suggest what the composer ought to dictate to the orchestra when nothing is doing or transacting on the stage: for if the symphony, as well as all dramatic music, is only a continued imitation, what is it to say when nobody speaks? What ought it to do when there is no action? "I answer to that (says Rousseau) that though the stage is vacant the heart of the spectator is not; there ought to remain a strong impression of what has been seen and heard. It is for the orchestra to cherish and sustain this impression during the intera<sup>c</sup>t, that the spectator at the beginning of the ensuing act may not find himself as cold as at the beginning of the piece, but that the interest may be as much linked in his mind as the events are in the action represented.

By this means the musician will always have an object of imitation, either in the situation of the personages, or in that of the spectators. These should hear nothing from the orchestra but expressions of what they have felt, identified with what they hear; and their situation will be so much the more delicious, as there shall be a more perfect accord between that which strikes their senses and which touches the heart.

An able musician will draw from the orchestra another advantage, which will contribute to give the representation all the effect possible, in conducting the spectator, by degrees, to the state of mind the most favourable to the effect of the scenes which are going to be represented in the following act.

The intera<sup>c</sup>t has no fixed duration; but it is supposed to be more or less considerable, in proportion to the time necessary for that part of the action, which is passed behind the scenes. However, that duration should have its bounds of supposition, relative to the hypothetic duration of the whole action; and the real bounds relative to the duration of the whole representation.

This is not the place to examine whether the rule of 24 hours is well founded, and if it ought never to be violated. But if we would give to the supposed duration of an intera<sup>c</sup>t bounds regulated by the nature of things, I see no other rule than that of the time during which no sensible and regular change happens in nature, which cannot be made apparently transacting on the stage during the intera<sup>c</sup>t. Now this time being 12 hours, which compose a day or a night, if that is exceeded, there is no longer any possibility of illusion during the supposed length of the act."

This is reviving the old contention concerning the unities, which have never been received as a law in this country. And as to act-tunes analogous to the business of the drama, it is an idea which was executed by Purcell in many of the plays of Dryden and Congreve; and Arne, when composer in salary at Drury-lane theatre, composed very pleasing and appropriate act-tunes to many of the stock plays, which never were printed, but preserved in MS. in the archives of the old theatre; but we suppose that the strains of Orpheus or Amphion might be as easily recovered now as these compositions.

ENTRAIGUES, in *Geography*, a small town of France, in the department of the Aveyron, chief place of a canton,

in the district of Espalion, with a population of 1748 individuals. It is situated near the place where the river Truyere falls into the Lot, 18 miles S. of Aurillac. Its canton contains 6 communes, and 6691 inhabitants, on a territorial extent of 147½ kilometres.—Also, a small town of France, in the department of the Isère, chief place of a canton, in the district of Grenoble, with a population of 521 individuals. The canton contains 10 communes and 4988 inhabitants, on a territorial extent of 355 kilometres.—Also, a small town of France, in the department of Vaucluse, 6 miles N.E. of Avignon.

ENTRAILS, the intestines or guts of an animal. See *INTESTINES*.

Menage derives the word from the barbarous Latin, *interalia*, formed of the Greek, *εντερον*, *intestine*.

ENTRAILS is also used, in a more extensive sense, for the viscera, or all the parts contained in the cavities of the bodies of animals. See *VISCERA*.

The aruspina of the ancients was employed in considering the entrails of victims; as the heart, lungs, liver, &c. See *ARUSPICES*, &c.

ENTRANCE, in *Sea Language*, is a name often given to the foremost part of a ship under the surface of the sea.

ENTRANCE of hounds, a phrase used by our *Sportsmen*, to express the instruction of these creatures in the art of hunting. They are said to be entered when they are thoroughly taught this.

The time of entering of hounds is when they are about twelve months old; when they are first brought up from their walks, they should be kept separate from the pack: they are then to be taught to take the water and swim; they are to be laid abroad in the heat of the day, to enure them to fatigue and exercise; and they must be frequently led through flocks of sheep, and warrens, to use them to be under command, and to know that they are to run at nothing but what the huntsman orders. They must be carefully instructed each to know his own name, and to understand the voice of the huntsman, and the notes of the horn used in hunting; and finally, to use their own language in a proper manner. When young hounds well know and answer to their names, they should be put into couples, and walked out amongst sheep; and if any be particularly snappish leave the couples loose about their necks in the kennel, till they are more reconciled to them. If any of them should be very troublesome, couple them to old hounds, always avoiding coupling two dogs together, if possible, and taking care that the couples be tight enough to prevent their heads being slipped out of the collar. After being walked out frequently amongst the sheep, they may be uncoupled, a few at a time, and such as offer to run after them should be well chastised; the cry of *ware, sheep*, will afterwards stop them, without further application of the whip; proper attention will soon make them ashamed of it; but if once suffered to taste the blood, it will be difficult to reclaim them. If young and old hounds are aired together, let the former be in couples; they are always ready for mischief, and idleness may induce even the latter to join in it. It may be as well to air the young hounds in that country where they are designed to hunt, as they thus acquire some knowledge of it, and if at any time they should be left behind, they will more readily find their way home. Young hounds should be entered as soon as you can; in woodlands and grasslands, it will of course be earlier than in corn countries. Sport in fox-hunting cannot be said to begin before October; but in the two preceding months, a pack is either made or marred.

## ENTRANCE.

The best time of entering them is about noon; and it should be in a fair warm day; for if they be entered in the morning, they will give out when the heat of the middle of the day comes on, and betake themselves to shady places to rest and sleep. Accordingly it is said that hounds should be entered in the heat of the day, and about October or November, for hare-hunting, the weather being then temperate, and young hares that have not been hunted are then more easily taken for their encouragement. A necessary caution is also added, never at the entering of young hounds to help them to kill the hare with grey-hounds, for this will deter the hounds from putting their noses to the ground, or trying to hunt her themselves. Take the most advanced, that the game may not stand long before them, and let them be well rewarded when all is over. This ought to be repeated at least once a week, for two months successively; by this means they will be so fleshed and seasoned with what game you may enter them at, that they will never afterwards leave off the pursuit. Hounds, after two years old, should be hunted three times a week, if they feed well, and may be kept out the greatest part of the day to try their stoutness. The new hounds should always be entered with the best and staunchest hounds that can be had; and there is not to be one barking dog suffered in the field on this occasion.

Whatever chace the hounds are intended for, it has been said that the hare is the best game to enter them at, because in this chace, they will learn all the turns and doubles that they can possibly meet with in any other kind, and how to come to the hollo. They will learn also from this chace, to have a perfect and nice scent, and hard feet, by being used to highways, beaten paths, and dry hills.

On the other hand, it has been more reasonably maintained, that young hounds should always be entered at their own game; because it is a strange contradiction to enter them at a hare; and then to cut them to pieces for afterwards hunting the hare. This, it is said, is laying a foundation for future cruelty and vexation. Most dogs like that scent best, which they were first blooded to; and if the blood of the fox be of so much service, that of the hare cannot be deemed a matter of indifference. It is, therefore, without doubt most rational to use them to that scent *only*, which it is intended they should hunt. It has been asserted, that the way to render hounds steady from hare, is to encourage them to hunt her. The advantage resulting from this kind of paradoxical practice is said to be, that hounds are thus taught to hunt, and made to learn obedience; but the surer method to make hounds obedient is calling them over often in the kennel, to accustom them to their names, walking them out frequently amongst sheep, hares, and deer, from which they are to be stopped, to make them know a "rate;" and by this practice they will learn obedience. Nature will instruct them how to hunt: art is only necessary to prevent their hunting what they ought not to hunt. Should any young hounds be very fond of hare, let some be found sitting, and started before them, they will soon be checked and cease to run after them. If they are to be steadied from deer, they should often see deer, and they will not regard them. After this probation, a cub should be turned out before them, with some old hounds to lead them on, and they will not long give trouble. After young hounds stoop to a scent, are become handy, know a "rate," and stop easily, put them, a few only at a time, into the pack after the old ones have been hunted and had blood; let them be taken the first day where they are certain of finding. Hounds should be low in flesh when hunting commences; because the ground being generally hard

at that season, they are liable, if lusty, to be shaken. If foxes are plentiful, take the young, with some of the steadiest of the old hounds, where there is least riot, and should you there find a litter of foxes, the young hounds will be so much improved as to need little subsequent instruction. If any cubs be ran to ground, and blood be not then wanted, let them be brought home, and they will be serviceable, should blood be necessary at any time for the young hounds. Frequent hallooing is of use with young hounds, as it keeps them forward, prevents their being lost, and from hunting after the others: the more, therefore, a fox is seen and halloed, the better. Young hounds are thus made eager, and taught to exert themselves. At their first entering, hounds cannot be encouraged too much: when they are handy, love a scent, and begin to know what is right, it will be soon enough to chastise them for doing wrong; in which latter case, one severe beating will save much trouble. The whipper-in should use his voice as well as his whip, when he flogs a hound, and take care that the stroke precedes the "rating;" and he should remember, that the smack of the whip is often as serviceable as the lash to one who has already felt it. The day after young hounds have had blood is a proper time to take them where there is riot, and if they merit it, to chastise them: it is always best to correct them, when they cannot help knowing what they are corrected for. When hounds go out for this purpose, it should be at a late hour; as the worse the scent is, the less inclinable will they be to run it, and the stopping of them will be more easy and immediate. Upon the day when a fox is proposed to be turned out, young hounds should draw small covers and furze brakes, where are hares or deer; a little rating and flogging, before they are encouraged to vermin, teaches them both what they should not and what they should do. A hound that hears a voice which has often rated him, and the whip he has often felt, ought to stop: when hounds are rated, and do not answer the rate, they should be coupled up immediately, and made to know the whipper-in. A most essential point in rendering hounds obedient is to make them understand you; and therefore the language should be appropriate and uniform. Young hounds should be hunted in large covers to tire them out, provided the whipper-in can easily get at them; but when there is much riot there are no openings, the purpose will not be answered, unless you have a body of old hounds to carry on the right scent: for the young hounds, as soon as the ground becomes foiled, will be scattered about the cover, hunting old scents, and will not proceed fast enough to tire themselves. Besides, every fox-hound will leave a bad scent of a fox for a good one of either hare or deer, unless he has been made steady from both. Young hounds are all given to riot; but the better they are bred, the less trouble will they be likely to give: high bred fox-hounds love their own game best: they should have little rest; one day they should be hunted in large covers, where foxes are plentiful; the next, they ought to be walked out amongst hares and deer, and stopped from riot; and the day following, be hunted again as before. By this management young hounds will soon become steady. At first young hounds should be entered to vermin only; and they should be used as early as possible to the strongest and thickest woods and furzes, and they will seldom be shy of them afterwards. By being awed from hare and deer, and being taught to hunt only vermin, hounds will stop at a word, because that word will be understood by them; and a smack of the whip will spare the inhuman trouble of cutting hounds in pieces for faults, which, if entered at hare, they have been invited to commit.

In hare-hunting the hounds, when first entered, must have all the advantages given them that can be. When the hare is put up, from her form, it must be observed which way she went, and the scent must be left to cool a while, and then they must be laid in, and helped as much as can be, by wind, view, hollo, or pricking the passage; nor will it be amiss, for the first time, to give them a hare tired the same morning in her course.

Some are of opinion, that the best way to enter young hounds is, to take a live hare, and trail her upon the ground, sometimes one way, and sometimes another, and then to draw her off to a convenient distance, and hide her, that the dogs, taking the scent, may follow all the traces through which she was drawn, and at length find her.

It has been said, however, that beating the hare up from her seat is a shorter way than trailing her from her feed to her form. Great exactness was formerly observed in the first entering of hounds, not to uncouple them repeatedly in the same sort of ground, lest by being uncoupled constantly in an open field, they would be at a loss what to do when turned into a cover. It was a received opinion, that according to the places where hounds were first entered, they would shew a preference: *e. g.* if entered in a champaign country, they would always hunt better there than in covers, marshy, or mountainous grounds. Hence it was deemed right to use them to every sort of ground, and diversity in the country was strongly recommended, that they might be perfect in all. Some lands, which were of a glutinous and greasy shining mould, never bore any scent, and there the huntsman was to help out the dogs by pricking the hare. In plains and downs where the grass was short, and the scent dried immediately, there also he was allowed to follow his game by the eye, in order to assist the nose of the hounds. Some of the early sportsmen never permitted the hare to be hallooed, or the hounds to be assisted when they were at fault, but suffered them to work it out by themselves; and this, though tedious, was considered a sure way to ascertain the goodness of the hounds: others took all advantages, and killed them as speedily as possible. The method of rewarding the young hounds was curious. The hare, after being laid upon the grass, and bayed by the hounds, was skinned before them; and after the gall and lights were taken away, which were supposed to make the hounds sick, the huntsman, who carried a wallet with bread cut in small pieces, dipped them in the blood, and with the entrails gave them to the hounds; the hare was afterwards distributed, and if any young hound was fearful to come in among the rest, he had the head given him by himself. After this feast, the hounds had bread given them to prevent sickness.

The huntsman ought very well to understand the nature and disposition of his hounds, in finding out the game; for some hounds are of that temper, that when they have found the scent, they will run forward with it, not making any noise, nor shew of the tail; others, when they have found a head, will shew the game; and some, having found the footings of the beast, will prick up their ears a little, and either bark, or only wag their ears, or the hinder part of their bodies. This difference of natural disposition, the huntsman is particularly to observe in the young and newly entered pack, otherwise he will never understand them, nor ever be able to hunt them to any credit or advantage.

For entering the hound at hart or buck, he should be in the prime of grease, for then he cannot stand up, or hold the chace so long. The forest pitched upon should have all the relays at equal distances, as nearly as may be; but then

the young hounds should always have some old staunch ones to enter them, and they should be led to the farthest and last relay, and the hart or buck should be hunted to them. Being come up, the old hounds should be uncoupled; and when they have found the hart, and well entered the cry, then the young ones are to be uncoupled also; and if any of them are found to lag behind, they must be whipped and beaten forward.

In whatever place the hart is killed, the neck should be immediately flayed, and the hounds rewarded; for it is best always to do this while the flesh is hot. Another very good method of entering hounds at the buck, is to take one in the toils or nets, and to wound one of his legs, so as to disable him from running either very swiftly or very far: then let him loose, and first let a blood-hound trace the creature, then let loose all the young hounds; and when they have run down the animal, reward them with the neck.

Some enter their hounds with a toil; but this is a bad way; for the hart being in this case always in fight, and not able to run an end, makes a great number of doubles and turnings: this is very different from the chaces they are to meet with afterwards; and when they find a hart run in the common way, straight forward, and out of sight, they will leave the chace, as unlike that by which they were taught. Daniel's Rural Sports. See HUNTING.

ENTRASME, in *Geography*, a small town of France, in the department of Mayenne; 6 miles S. of Laval.

ENTRAVES, ENTRAVONS, in the *Manege*. See LOCKS.

ENTRE AMBOS OS RIOS, in *Geography*, a town of Portugal, in the province of Entre Minho Douro; 8 miles S.S.W. of Amarante.

ENTRE Minho Douro, a province of Portugal, so called from its situation between the rivers Minho and Douro, bounded on the north by Galicia, a province of Spain; on the east by Trazos Montes and Spain; on the south by the province of Beira, from which it is separated by the Douro; and on the west by the Atlantic ocean; and extending from 40° 50' to 42° N. lat., and from 8° 55' to 7° 55' W. long., being 70 miles in length and 52 in breadth. It contains 963 parishes, 1460 churches, 1130 convents, 6 sea-ports, and 804,000 inhabitants. This is the most northerly, the most fertile, and the most populous territory in the kingdom. Its numerous and fine vallies are shaded by beautiful trees, and watered by limpid streams. Its air is pure and healthy; and it produces corn, wine, oil, and flax in abundance, with a great number of sheep, and plenty of game and fish. The principal towns are Braga, Oporto, Viana, Amarante, Guimaraens, Ponte de Lima, and Pezo de Regna. Its chief rivers are the Minho, Lima, Neiva, Cavado, Ave, and the Douro or Duero, augmented by the Tamega; all of which run westward to the sea.

ENTRECASTAUX, a small town of France, in the department of the Var, near Barjols.

ENTRÉE, *Tr.*, the overture to a ballet, and sometimes the beginning of the dance itself. In the first operas in France, the overture was called the entrée.

ENTREPAS, in the *Manege*, is a broken pace, or going, properly a broken amble, that is, neither walk nor trot, but has somewhat of an amble. This is the pace, or gait, of such horses as have no reins or backs, and go upon their shoulders, or of such as are spoiled in their limbs.

ENTREVEAUX, in *Geography*, a small town of France, in the department of the Lower Alps, chief place of

of a canton in the district of Castellane, with a population of 1326 individuals. It is situated at the foot of the Alps, on the river Var, near Glandeves. N. lat.  $44^{\circ} 1'$ . Its canton has a territorial extent of  $197\frac{1}{2}$  kilometres, eight communes, and 2694 inhabitants.

**ENTRICOMA**, from *ε* and *τριξ*, *hair*, in *Anatomy*, the name of the outer edge of the eye-lid, on which the hairs grow.

**ENTRIES**, amongst *Hunters*, those places in thickets through which deer are found lately to have passed; by means whereof their bigness or size is guessed at; and at which the hounds or beagles are put to them for the view.

**ENTRIES**, *Books of*, in *Law*, are ancient and modern, and contain transcripts of proceedings that have been had in some particular actions; the principal of such are necessary for gentlemen educated to the profession of the law.

**ENTRING a Ship**, in *Sea Language*, the same with boarding her. See **BOARDING**.

**ENTRING-Ladder**, in a *Ship*, is of two sorts; one is used by the ship's sides, in a harbour, or in fair weather, for persons to go in and out of the ship: the other is made of ropes, with small staves for steps, and is hung out of the galley to enter into the boat, or to come aboard the ship from thence, when the sea runs so high that they dare not bring the boat to the ship's side for fear of staving her. See **GANG-WAY**.

**ENTRING-Ropes**. See **ROPE**.

**ENTROCHUS**, in *Natural History*, the name of a genus of fossils of a very regular figure and structure, supposed by many authors to be lapides sui generis, and stones in their native state. They are, however, in reality, the fossil remains of some marine animal, probably either of the echinus, or of the star-fish kind, filled like the fossil species of the echini, with a plated spar. Our imperfect knowledge in the animal history has not yet been able to ascertain to what creature they really belong; but their analogy, with the other animal remains, found in the fossil world, plainly evince, that they are of that origin. They are cylindrical columns, usually about an inch in length, and are made up in a number of round joints, like so many small wheels or segments of cylinders. These joints, when found separate, and naturally loose, as they sometimes are, are called trochitæ. They are all striated, from the centre to the circumference, and have a cavity in the middle, which is sometimes found empty, but more frequently filled up with various matter, of the nature of the stratum, in which they have lain, or of other of the native fossil substances.

The entrochi are composed of the same sort of plated spar with the asterizæ, and the spines and shells of the fossil echini: and this is in these usually of a blueish-grey colour, and very bright and glossy, when fresh broken. They are subject to accidental injuries, like the other extraneous fossils, which have been formed in animal moulds, and are frequently met with compressed, or crooked.

That the entrochi are of marine origin, is evident from this, that they have not unfrequently sea-shells found adhering to them; and when these are broken off, there remain on the entrochi no deficiencies, but the shells themselves shew that they have been formed upon, and have grown to the entrochi, there being always natural hollows in them to answer to that part of the entrochus from which they have been separated; whence it appears very plainly, that these entrochi, however altered since in their substance,

were, however, existing in their present shape, in those very seas where these shells had their growth.

There are not unfrequently found among the entrochi, larger or smaller fragments of plated bodies.

We meet with the entrochi of all the sizes, from that of a pin's head to a finger's length, and the thickness of one's middle finger. They are, in some places, found loose upon ploughed lands; in others, they are lodged in great quantities in the strata of clay, and very often in stones of different kinds, and different hardness.

Mr. Parkinson, in his second volume of "Organic Remains," treats very largely of this class of animals; and Mr. William Martin, in his recent and valuable work, the "Petrificata Derbiensia," has paid considerable attention to the curious remains of this kind which Derbyshire affords: among which he enumerates, 1st, the even-jointed entrochite (*Entrochites lævis*); 2d, the convex-jointed entrochite (*E. prominens*); 3d, the warted entrochite (*E. verrucosus*); and 4th, the ring-jointed entrochite (*E. canulatus*).

Entrochi abound in some particular beds of the first or upper lime-stone rock of the Derbyshire lime-stone or toad-stone series, and from hence the beautiful figured marbles are principally obtained, at Ricklow-dale, Bricks, and High-low, near to Monyash; at Foolow, Calver, Lexley in Ashover, Crick-Cliff, and other places. The three other lime-stone rocks, which lie below the above, contain some few beds with a sprinkling of entrochi in them; but they are very inferior in number or size to those in the upper rock.

Entrochi are also found in small numbers, in the yellow or magnesian range of lime-stone, which traverses the country from Wetherby in Yorkshire to near Nottingham; appears again at Bredon, Cloud's-hill, Barrow-hill, and Gracedieu in Leicestershire; again at Rushall and Walfall; between Wolverhampton and Dudley in Staffordshire; at Abberley in Worcestershire, &c.

The fossil described by Mr. Walcot, in his "Petrifications found near Bath," p. 46, under the name of an entrochus, is more properly a trochus or top-stone, very different from the entrochi of which we have been speaking: it belongs to the Bath free-stone strata.

**ENTROCHO Asterizæ**, the name given by authors to a peculiar kind of entrochus, differing from the common kind, in having a stellar cavity instead of a round one, in its centre.

**ENTROCHUS Pyramidalis**, a name given by some writers to the ortho-ceratites, or tubulus marinus concameratus, a species of shell-fish, not known to us in its recent state, but very common in the stones brought over from Sweden for pavements. Klein. de Tubul. Marin. p. 7. See **TUBULI Concamerati**.

**ENTROCHUS Ramosus**, the name of a fossil body, the several parts of which resemble the entrochi; but as they are joined together in this body when perfect, they shew themselves in their proper light, and a sight of them in this state is sufficient to explode the opinion advanced by some persons, of the entrochi being of a vegetable nature; or, as they have pleased to call them, "rock-plants." The fossil has evidently once been a stella-marina, or sea star-fish, consisting of twenty rays at the extremity of the body. The manner of insertion of these has been this: the body is of a pentagonal figure, and from this there have arisen five rays; these, at their extremity, have been divaricated, each into two, so as to make the number ten in the second progression; and each of these last being again divaricated into two

at its extremity; the third and last progression is of twenty rays. All this is easily distinguishable in the fossil, when perfect, and seems to have been the whole figure of the animal while living. The prototype, or living animal, however, is not found; but this is not an accident peculiar to this fossil, the cornua ammonis, and conchæ anomicæ, with many other bodies that have been once evidently shell-fish, being no where at this time found in their recent state, though so very numerous in the fossile world. This remarkable fossile star-fish is the body called by some authors, *lilium lapidium*. Keppeler's *Epist. ad Klein de Entrochis*.

ENTROCHORUM RADIX. See RADIX.

ENTROPNIUM, (from *εν* and *τροπω*, to turn,) a surgical disease, in which the eyelid turns inward towards the eye, so as to occasion, by the friction and irritation of the eyelashes, chronic ophthalmia, and various inconveniences. See TRICHIASIS.

ENTRUSION, in Law. See INTRUSION.

ENTRY, or ENTRANCE, in its general sense, denotes a door, gate, passage, &c. through which to enter, or arrive within a place.

ENTRY, in Book-keeping. See BOOK-KEEPING.

ENTRY, Bill of. See BILL.

ENTRY, is sometimes also used to denote a duty or impost laid on commodities imported into a state, either by land or sea.

The duties of entry, or importation, are paid according to a tariff settled for that purpose. Where the duty of entry of any commodity is not fixed by the tariff, it is paid by estimation, *i. e.* in proportion to what some other commodity of nearly the same quality and value uses to pay. In making entries inwards, it is usual for merchants to include all the goods they have on board the same ship in one bill, though sometimes there may happen to be upwards of twenty several kinds; and in case the goods are short entered, additional or port entries are now allowed; though formerly the goods so entered were forfeited. As to bills of entry outwards, of including goods to be exported, upon delivering them and paying the customs, you will receive a cocket, which testifies your payment thereof, and of all duties for such goods. If several sorts of goods are exported at once, of which some are free, and others pay customs, the exporter must have two cockets, and therefore must make two entries. Entries of goods, on which a draw-back is allowed, must likewise contain the name of the ship in which the goods were imported, the importer's name, and time of entry inwards. The entry being thus made, and an oath taken, that the customs for these goods were paid as the law directs; you must carry it to the collector and comptroller, or their deputies; who, after examining their books, will grant a warrant, which must be given to the surveyor, searcher, or land-waiter, that they may certify the quantity of goods; after which the certificate must be brought back to the collector and comptroller, or their deputies, and oath made, that the said goods are really shipped, and not landed again in any part of Great Britain. See DEBENTURE, IMPORTATION, and EXPORTATION.

ENTRY, also denotes a solemn reception, or a ceremony performed by kings, princes, ambassadors, legates, &c. upon their first entering a city, or their return in triumph from some expedition.

ENTRY, in Law, signifies the taking possession of lands or tenements by the legal owner, when another person, who hath no right, hath previously taken possession of them. See POSSESSION.

In this case the party entitled may make a formal, but

peaceable entry thereon, declaring that thereby he takes possession; which notorious act of ownership is equivalent to a feudal investiture by the lord (see INVESTITURE); or he may enter on any part of it in the same county, declaring it to be in the name of the whole (Litt. § 417.); but if it lies in different counties, he must make different entries; for the notoriety of such entry or claim to the *parcs* or freeholders of Westmorland, is not any notoriety to the *parcs* or freeholders of Suffex. Also, if there be two disseisors, the party disseised must make his entry on both; or if one disseisor has conveyed the lands with livery to two distinct feoffees, entry must be made on both (Co. Litt. 252.); for as their *seisin* is distinct, so must also be the act which divests that *seisin*. If the claimant be detained from entering by menaces or bodily fear, he may make *claim*, as near to the estate as he can, with the like forms and solemnities; which claim is in force for only a year and a day. (Litt. § 422.) And this claim, if it be repeated once in the space of every year and day (which is called *continual claim*) has the same effect with, and in all respects amounts to, a legal entry. (Litt. § 419, 423.) Such an entry gives a man *seisin*, (Co. Litt. 15.) or puts into immediate possession him that hath right of entry on the estate, and thereby makes him complete owner, and capable of conveying it from himself by either descent or purchase. This remedy by entry takes place in three only of the five species of ouster, *viz.* abatement, intrusion, and disseisin (Co. Litt. 237, 238.); for as in these the original entry of the wrongdoer was unlawful, they may therefore be remedied by the mere entry of him who hath right. But, upon a discontinuance or forfeiture, the owner of the estate cannot enter, but is driven to his action; for herein the original entry being lawful, and thereby an apparent right of possession being gained, the law will not suffer that right to be overthrown by the mere act or entry of the claimant. Yet a man may enter on his tenant by sufferance; for such tenant hath no freehold, but only a bare possession; which may be defeated, like a tenancy at will, by the mere entry of the owner. But if the owner thinks it more expedient to suppose or admit such tenant to have gained a tortious freehold, he is then remediable by writ of entry, *ad terminum qui præterit*. (Co. Litt. 57.) On the other hand, in case of abatement, intrusion, or disseisin, where entries are generally lawful, this right of entry may be *toll'd*, that is, taken away by descent. Descents, which take away entries (Litt. § 385—413.) are, when any one, seized by any means whatsoever of the inheritance of a corporeal hereditament, dies, whereby the same descends to his heir; in this case, however feeble the right of the ancestor might be, the entry of any other person who claims title to the freehold is taken away; and he cannot recover possession against the heir by this summary method, but is driven to his action to gain a legal *seisin* of the estate. In general it appears, that no man can recover possession by mere entry on lands, which another hath by descent. And this title of taking away entries by descent is still further narrowed by the statute 32 Hen. VIII. c. 13. which enacts, that if any person disseises, or turns another out of possession, no descent to the heir of the disseisor shall take away the entry of him that has right to the land, unless the disseisor had peaceable possession five years next after the disseisin. But the statute extendeth not to any feoffee or donee of the disseisor, mediate or immediate. (Co. Litt. 246. 256.) By the statute of limitations it is enacted by statute 21 Jac. I. c. 16, that no entry shall be made by any man upon lands, unless within 20 years after his right shall accrue: and by statute 4 and 5 Ann. c. 16, no entry shall be of force to satisfy the said statute of limitations,

tions, or to avoid a fine levied of lands, unless an action be thereupon commenced within one year after, and prosecuted with effect. Moreover, this remedy by entry must be pursued, according to statute 5 Ric. II. st. 1. c. 8. in a peaceable and easy manner; and not with force or strong hand. For, if one turns or keeps another out of possession forcibly, this is an injury of both a civil and criminal nature. The civil is remedied by immediate restitution; which puts the ancient possessor *in statu quo*; the criminal injury, or public wrong, by breach of the king's peace, is punished by fine to the king. Blackstone's Comm. b. iii. See FORCIBLE Entry.

ENTRY, *writ of*, is a possessory remedy, which disproves the title of the tenant or possessor, by shewing the unlawful means by which he entered or continues possession. (Finch. L. 261.) This writ is directed to the sheriff, requiring him to "command the tenant of the land that he render (in Latin, *præcipe quod reddat*) to the demandant the land in question, which he claims to be his right and inheritance; and into which, as he saith, the said tenant had not entry but by (or after) a disseisin, intrusion, or the like, made to the said demandant, within the time limited by law for such actions; or that upon refusal he do appear in court on such a day, to shew wherefore he hath not done it. This is the original process, the *præcipe*, upon which all the rest of the suit is grounded; wherein it appears, that the tenant is required, either to deliver seisin of the lands, or to shew cause why he will not. This cause may be either a denial of the fact, of having entered by or under such means as are suggested, or a justification of his entry by reason of title in himself, or in those under whom he makes claim; whereupon the possession of the land is awarded to him who produces the clearest right to possess it.

Writs of entry are of divers kinds, distinguished into four degrees, according to which the writs are varied. The first degree is a writ of entry *sur disseisin*, that lieth for the disseisee against a disseisor, upon a disseisin done by himself; and this is called a writ of entry in the nature of an assise. The second degree, by some reckoned the first, is a writ of entry *sur disseisin in le per* and lies against the heir by descent, who is said to be in the *per*, as he comes in by his ancestor; and so it is if a disseisor make a feoffment in fee, gift in tail, &c. The feoffee and donee are in the *per* by the disseisor. The third is a writ of entry *sur disseisin in le per and cui*, where the feoffee of a disseisor maketh a feoffment over to another; when the disseisee shall have this writ of entry *sur disseisin*, &c. of the lands in which such other had no right of entry, but by the feoffee of the disseisor, to whom the disseisor demised the same, who unjustly and without judgment disseised the demandant. (1 Inst. 238.) These three degrees thus state the original wrong, and the title of the tenant who claims under such wrong. If more than two degrees (that is, two alienations or descents) were past, there lay no writ of entry at the common law. For, as it was provided, for the quietness of men's inheritances, that no one, even though he had the true right of possession, should enter upon him who had the apparent right by descent or otherwise, but he was driven to his *writ of entry* to gain possession; so, after more than two descents or conveyances were passed, the demandant, even though he had the right both of possession and property, was not allowed this possessory action, but was driven to his *writ of right*, a long and final remedy, to punish his neglect in not sooner putting in his claim, while the degrees subsisted, and for the ending of suits, and quieting of all controversies. (2 Inst. 153.) But by the statute of Marlbridge, 52 Hen. III. c. 30, it was provided, that when the number of alienations

or descents exceeded the usual degrees, a new writ should be allowed without any mention of degrees at all. Accordingly a new writ, or a fourth, has been framed, called a writ of entry in the *post*, which only alleges the injury of the wrong-doer, without deducing all the intermediate title from him to the tenant; stating it in this manner; that the tenant had not entry unless *after*, or subsequent to, the ouster or injury done by the original disseisor; and rightly concluding, that if the original title was wrongful, all claims derived from thence must participate of the same wrong. Upon the latter of these writs it is (the writ of entry *sur disseisin* in the *post*) that the form of our common recoveries of landed estates is usually grounded. See FINE and RECOVERY.

This remedial instrument of writ of entry is applicable to all the cases of ouster (see OUSTER), except that of discontinuance by tenant in tail, and some peculiar species of forcements. Such is that of forcement of dower, by not assigning any dower to the widow within the time limited by law; for which she has her remedy by writ of *dower, unde nihil habet*. (F. N. B. 147.) See DOWER. But in general the writ of entry is the universal remedy to recover possession, when wrongfully withheld from the owner. It would, therefore, be endless to recount all the several divisions of writs of entry, which the different circumstances of the respective demandants may require, and which are furnished by the laws of England. (See Bracton, l. 4. tr. 7. c. 6. § 4. Britton, c. 114. fol. 264.) Of these the most usual were, 1. The writ of entry *sur disseisin*, and of intrusion (F. N. B. 191. 203.), which are brought to remedy either of the species of ouster. 2. The writs of *dum fuit infra aetatem*, and *dum fuit non compos mentis* (Ibid. 192. 202.) which lie for a person of full age, or one who hath recovered his understanding, after having, (when under age or insane,) aliened his lands; or for the heirs of such alienor. 3. The writs of *cui in vita*, and *cui ante divorcium* (Ibid. 193. 204.) for a woman, when a widow or divorced, whose husband during the coverture hath aliened her estate. 4. The writ *ad communem legem* (Ibid. 207.) for the reversion, after the alienation and death of the particular tenant for life. 5. The writs in *casu proviso*, and in *consimili casu*, (Ibid. 205. 206.) which lay not *ad communem legem*, but are given by stat. Gloc. 6 Edw. I. c. 7. and Weitm. 2. 13 Edw. I. c. 24, for the reversioner after the alienation, but during the life of the tenant in dower or other tenant for life. 6. The writ *ad terminum qui præterit* (Ibid. 201.) for the reversioner, when the possession is withheld by the lessee or a stranger, after the determination of a lease for years. 7. The writ *causa matrimonii prælocuti* (Ibid. 205.) for a woman who giveth land to a man in fee or for life, to the intent that he may marry her, and he doth not: and the like in case of other forcements. These writs are plainly and clearly chalked out in that most ancient and highly venerable collection of legal forms, the "regitrum omnium brevium," or register of such writs as are sueable out of the king's courts, upon which Fitzherbert's "Natura Brevium" is a comment.

In the times of our Saxon ancestors, the right of possession seems only to have been recoverable by writ of entry (Gilb. Ten. 42.); which was then usually brought in the county-court. The proceedings in these actions were not then so tedious, when the courts were held, and process issued from and was returnable therein at the end of every three weeks, as they became after the conquest, when all causes were drawn into the king's courts, and process issued only from term to term, which was found exceedingly dilatory, being at least four times as slow as the other. Hence

a new remedy was invented, in many cases, to do justice to the people and to determine the possession in the proper counties, and yet by the king's judges. This was the remedy by *assise*, which see. Blackl. Comm. b. iii. For other particulars on the subject of this article, see Jacob's Law Dict. by Tomlins.

**ENTRY Island**, in *Geography*, one of the Magdalen islands in the gulf of St. Lawrence. N. lat. 46° 18'. W. long. 61° 20'.—Also, an island in the Pacific ocean, about nine leagues N. from Cape Tierawite and under the same shore, which may be distinctly seen from Queen Charlotte's Sound, at the distance of about six or seven leagues. The name was given to it by lieutenant Cook, who passed it in January 1770.

**ENTYPOSIS**, from *επιποσις*, *I make an impression*, in *Anatomy*, the articulation of the shoulder with the arm.

**ENTZERSTORFF**, in *Geography*, a town of Germany, in the archduchy of Austria; six miles S. of Laab.—Also, a town of Germany, near the conflux of the rivers Reitinpach and Reifenpach; 10 miles W.N.W. of Bruck.

**ENTZERSTORFF** in *Logenthal*, a town of Germany, in the archduchy of Austria; two miles S.E. of Corn Neuburg.

**ENTZERSTORFF** or *Stal-Entzerstorff*, a castellated town of Germany, in the archduchy of Austria, on the north side of the Danube, belonging to the bishop of Freysingen; 24 miles W. of Presburg and nine E. of Vienna.

**ENVERMEU**, a small town of France, in the department of the Lower Seine, chief place of a canton in the district of Dieppe, with a population of 896 individuals. The canton contains 40 communes and 13,402 inhabitants, on a territorial extent of 265 kilometres.

**ENVELOPE**, in *Fortification*, denotes a mount of earth sometimes raised in the ditch of a place, and sometimes beyond it, being either in form of a simple parapet, or of a small rampart bordered with a parapet.

These envelopes are made where weak places are only to be covered with single lines, without advancing towards the field, which cannot be done but by works which require a great deal of room: such as horn-works, half-moons, &c. Envelopes are sometimes called fillons contregards, conserve, lunettes, &c.

**ENVIRON**, among *Military Men*, relates to that complete investment of a town, or fortrefs, which utterly precludes the acquisition of supplies, or of reinforcements, and, in a general sense, may be said to be the basis of a blockade. When we say that a place is environed, we are not indiscriminately to conclude, that any circumvallation has taken place; but, that the country round is so completely possessed by the enemy, as to render any attempt to afford succour to the inhabitants unavailing. Thus, if there be several passes leading to a town situated in a valley, surrounded by mountains inaccessible, or impassable in every part, except at those passes; or if a town stands on a peninsula, of which the isthmus is cut off by the enemy, who likewise possess the navigation of the circumferent waters, such towns are, to all intents and purposes, environed; and, if the blockade be duly supported, must in time surrender merely from a want of supplies.

If, however, the enemy should not be strong enough to keep the inhabitants within close bounds, or if, notwithstanding the whole of the adjacent country may be under his controul, supplies may be attainable from the exterior, whether by connivance among the peasantry, or by the operations of enterprising partizans, then the place cannot be said to be environed. When we consider the many chances arising in favour of such garrisons as make a good

defence, it should appear to be the best policy, as well as the most honourable conduct, to hold out to the very utmost, and never to surrender except under the last extremity. As to being environed, or blockaded, it is sometimes a very important advantage gained by the defending power, because it must prove a complete diversion, by causing a very large force to be occupied in shutting up a comparative hand-full.

It, however, very rarely happens, that towns are, properly speaking, environed: the old system of circumvallation is now obsolete, except in very confined cases, and where there is no army in the field capable of raising the siege. We have, indeed, a recent instance of a large city, namely, Saragossa, having been environed; but it was under most peculiar circumstances; for the place fell rather from a want of an adequate force to cope internally with the assailants, though, on the other hand, the want of supplies was severely felt. If any thing could strengthen the recommendation we have just given, of continuing a defence to the last moment, surely the noble example shewn by that loyal and illustrious, but most unfortunate city, must serve as a stimulus, and prompt every person in charge of a besieged fortrefs, or town, to despise the efforts of the environing army, and to sell every inch of ground at the highest price that valour can impose on a superior force.

Those who undertake a blockade, by completely environing a town, &c. have a most arduous task to perform. They have not only to oppose the sallies of the garrison, but to keep a very sharp look-out against exterior attacks, which may often be so effectually made, by an enterprising partizan, as to coerce a very numerous army to considerable relaxation, such, indeed, as must prove favourable to the defenders. When we consider these circumstances, we shall be less surpris'd at the great losses sustained by besiegers, who, as well as the besieged, suffer under all the disadvantages attendant upon fixed camps; whereby not unfrequently the most destructive diseases are engendered.

**ENVIRONNE'**, in the *French Heraldry*, is when a lion or other figure is environed, or encompassed round with other things. Environné with so many bezants, &c. in orle.

**ENULA**, in *Botany*. See *INULA*.

**ENULION**, from *εν* and *ελευον*, the *gums*, a word used by some medical writers for the flesh of the gums.

**ENUMERATION**, the act of enumerating, or counting. At the time of our Saviour's birth, Augustus Cæsar had commanded an enumeration to be made of all the world, or rather of all the people under his empire: though several able authors are of opinion, that the census, tax, or enumeration mentioned by St. Luke, did not extend to the whole empire, but only to the people of Judæa. See Perizonius de Censu Judaico, and Berger de Viis Militaribus.

At Rome, it was an usual thing to have an enumeration made of all the families: the first of these was under Servius Tullius, when the men amounted to eighty thousand. Pompey and Crassus made another, when they reached to four hundred thousand. That of Cæsar did not exceed one hundred thousand; so that the civil wars must have destroyed three hundred thousand Roman citizens. Under Augustus, in the year 725, the Roman citizens throughout the empire were numbered at four millions sixty-three thousand. In the year of Rome 746, the citizens, being numbered again, were found four millions two hundred and thirty-three thousand. In the year 766, being the last year of Augustus's reign, that prince, together with Tiberius, made another enumeration of the citizens of Rome, when they were found four millions one hundred and thirty-seven thousand persons.

Claudius made a new computation in the year of Christ 48, when, as Tacitus relates it, the Roman citizens throughout the whole empire amounted to six millions nine hundred and sixty-four thousand; though others represent the number as considerably greater. A very rare, yet indisputable medal of Claudius, never yet made public, expresses the precise number in this list made by Claudius, which was called *ostensio*, to be seven millions of people fit to bear arms, beside all the soldiers on foot in the armies, which amounted to fifty legions, fifty-seven cohorts, and sixty soldiers. After this enumeration, we find no more till that of Vespasian, which was the last.

ENUMERATION, in *Rhetoric*, denotes a part of the peroration, wherein the orator, collecting the scattered heads of what has been delivered throughout the whole, makes a brief and artful rehearsal or recapitulation thereof. See RECAPITULATION.

ENUMERATION is also a rhetorical figure: for which see APARITHMESIS.

ENUMERATION of the parts, amounts to the same with what we more usually call distribution. In this part of rhetoric, the orator acquaints his hearers with the several parts of his discourse, upon which he designs to treat. See DISTRIBUTION and PARTITION.

ENUNCIATION, a simple expression or declaration of a thing, in terms either of affirmation or denial.

The schoolmen usually distinguish three operations of the understanding; apprehension, enunciation, and reasoning.

ENUNCIATION, among *Logicians*, denotes the same as proposition.

ENUNCIATION, which, without violation of etymology, might be applied to signify the whole act of speech or delivery of language, is, in conformity with the theory and system laid down under the article ELOCUTION, confined to the utterance and combination of the elements, and the consequent pronunciation of syllables, words, &c. as contradistinguished from the tones, and tuning of the voice, and all that belongs to the melody of speech.

The perfection of enunciation consists in the following particulars; 1. *Distinctness*, or the clear and perfect formation of the respective elements by right motions and positions of the organs of the mouth, accompanied by proper degrees of energy and impulse to impress those elements fully and contradistinctly on the ear. 2. *Articulation*, or the act of combining and linking together of the respective elements, so as to form them into intelligible syllables and words, capable of being again combined into clauses and sentences for the proper conveyance of our ideas, thoughts, and determination. 3. *Implication*, or the combination and apparent union of words in oral utterance, which are graphically separated; and by which, without injury to the intelligible distinctness of the respective words, all differences of auditory impressions are removed between monosyllabic and polysyllabic composition in language.

The faults immediately opposed to distinctness are, 1. *Mumbling*, or an indolence or want of precision in the action of the lips, affecting, of course, principally the labial sounds, but impeding, to a certain degree, the clear progress of the specific impulses given to other elements, by the interior organs of the mouth. 2. *Thickness*, or indolence and imperfection in the action of the tongue, and affecting, more or less, the whole or part of the lingual sounds. 3. *Drawling*, which results from indolence or inaptitude of the whole organs of speech, vocal as well as enunciative. These are defects of lethargy, or deficiency of organic action. Those that follow are of another description. 4. *Mouthing*, a pompous but dull species of indistinctness, which results from affectedly

pursing up the mouth, and consequent drawing the cheeks too close upon, or even between the teeth, during the act of speaking: it is one of the unsuccessful theatrical means of aiming at sublimity and pathos. 5. *Cluttering*, a species of St. Vitus's dance of the organs; hurrying them with too much rapidity and indecision from one elementary position to another, before the respective elements are completely formed, or have had time to make their respective impressions distinctly on the ear. This last is one of the fruitful sources of impediment of speech.

The faults opposed to articulation and implication are, a *sau-ul-ter-r-ing he-c-fi-i-ta-a-tion*, a *pulsative inter-rup-tion*, (such as is almost universally observable in the early reading of school boys, and which some people in their reading never get rid of as long as they live,) and a *pè-dan-tic for-má-li-ty*, such as was ridiculed in a gentleman, who, asking his friend if he came to town in his *cha-ri-ot*, was answered, no, sir, I came in my *co-ach*. But the contradiction, and even opposition, thus marked between distinctness and articulation, though so indispensable to the intelligible treatment of the subject of elocutionary science and instruction, is so little authorized by those who have hitherto treated upon these subjects, that the writer of this article deems it necessary controversially to refer to those authorities, and to state the objections to the customary and confused phraseology which they have sanctioned. Among these, some have defined the term articulation as if it embraced the whole art and practice of enunciative utterance, as the ingenious, and generally speaking, profound and accurate Mr. Gough,—“Articulation,” says he, “is the art of modifying the sounds of the larynx by the assistance of the cavity of the mouth, the tongue, teeth, and lips.” (Manch. Mem. vol. v. pt. ii. p. 645.) But much more frequently it is used as a pure synonym with *distinctness*. (Mr. Sheridan, in his lectures, confounds it not only with distinctness but with enunciation generally, and even with idiomatic pronunciation, Lect. ii. p. 21. 8vo. edit.) But, not to insist particularly upon the important axiom, that the very admission of synonyms is inconsistent with the progress and communication of scientific truth, if such were the use to which the term articulation were to be applied, why did the English grammarian go to the Greek language and to the science of anatomy to borrow a name for an idea which he had already a good and familiar English word fully and completely to convey? How came he to apply that word so superfluously borrowed in a sense diametrically opposite to that which it bears in the science from which it is taken? For articulation in anatomy signifies the *junction of bones*, or that flexible combination of joints or elementary portions into a limb, or of limbs into a body, by which the unity of the whole is constituted, without injury to the individuality of the parts. And lastly, how came he to look out for a supernumerary name to one idea, while another idea equally indispensable to his science (for the combination of elements is as necessary to speech as their formation) without any separate or specific designation? Without going further, therefore, into critical disquisition, we may venture to lay down, as one of the canons of elocution and grammatical nomenclature, the following definition.—Articulation (as one of the essential properties of human enunciation, is the jointing or linking together of the respective elements, and syllables, and words (the portions, limbs, and members of sentences) as the bones themselves, (the portions, limbs, and members of the anatomical frame) are linked or jointed together, by an analogous articulation in animal economy. Implication will then remain to be considered merely as that part of articulation which relates separately to the articula-

tion of separate graphic words in the act of oral delivery, and consequently as indicating rather a grammatical distinction, than a distinct species or modification of organic action: for in well delivered speech (it is contended, by the authority so frequently referred to in the different articles relative to elocution) the ear, unassisted by the memory of the eye, knows of no such thing as a division or distribution of speech into such separable portions as in graphic composition are denominated words. The process of enunciation and implication consists in a delicate precision of the motion of the organs, without cessation of sound, from one elementary position to another, by which the termination of the perfect sound is glided more or less intimately into the succeeding element or commencement of the ensuing syllable. Thus literal sounds, intimately glided into each other, are articulated into syllables; as, *a* and long *l* into *all*. Syllabic sounds, intimately glided into each other, are articulated into words; as, *all* and *ways* into *always*. The terminations of words (as they are called in conformity with graphic distinctions) glided into the initial sounds of succeeding words, are implicated into clauses, or parts of clauses; as the man, a ship, an apple,

Harry to Harry might, and horse to horse, &c.

A good enunciation, then, consists in that clear and accurate delivery of verbal language, by which the requisite qualities of distinctness and articulation are combined and modified; and the due proportions and alterations of sound and interruptions, constituting the specific relations of letters, syllables, members, clauses, and sentences, are preserved in discourse or reading.

ENUNCIATIVE ORGANS, those portions and members of the human mouth, by the motions, positions, and contact of which, specific character is superadded to the original impulses of voice, so as to render them communicable signs of distinct ideas. See ORGANS of Speech.

ENVOICE. See INVOICE.

ENVOY, a public minister sent by one sovereign prince or independent state to another to negotiate some affair, or to watch over the interests of that state or prince in general, and furnished with the credentials of an envoy. Like ambassadors, envoys may be either *ordinary*, who reside permanently at the court of a foreign prince, or *extraordinary*, who are dispatched for one particular purpose, and retire when their mission is accomplished. Envoys hold the second rank among public ministers sent to foreign courts: but they are alike under the special protection of the law of nations, and enjoy all the privileges and immunities of ambassadors, except those relating to the ceremony of their reception, public entry, and solemnity of their audiences. See EMBASSADOR.

The quality of envoy extraordinary, Wicquefort observes, is very modern; more modern than that of resident: the ministers invested therewith, at first, took on them most of the airs of ambassadors; but they have since been taught otherwise.

In the year 1639, the court of France made a declaration, that the ceremonies of conducting envoys extraordinary to their audience in the king and queen's coaches, with divers others, should no longer be practised to envoys.

S. Justiniani, the first envoy extraordinary from Venice, after that regulation, offered to cover in speaking to the king, but it was refused him; and the king of France himself declared, that he did not expect his envoy extraordinary at the court of Vienna should be regarded any otherwise than as an ordinary resident. Since this time, those two kinds of ministers have been treated alike. Wicquefort.

ENURE, in *Law*, signifies to take place, or be available, and is as much as to have effect. Thus for instance, a release made to tenant for life shall enure, and be of force and effect to him in the reversion.

ENURESIS, in *Medicine*, from *en* and *ὄστρος*, *mingendi astus*, the nosological term for incontinence of the urine. See URINE, incontinence of.

ENVY, in *Ethics*, is defined by Mr. Locke to be an uneasiness of mind, occasioned by the consideration of a good we discover in possession of another person, whom we deem less worthy of it than ourselves. It is a composition of sorrow and hatred, and stands in direct opposition to congratulation. Otherwise, envy entertains a degree of sorrow that the good contemplated should escape ourselves, and of anger that it should fall to the share of another. Or, it is that species of malevolence which is inspired by the conjoined influence of pride, sorrow, and anger. It differs from *emulation* (which see), or a disquiet, occasioned by the felicity of another, not because he enjoys it, but because we desire the like for ourselves; as it occasions an uneasiness not merely from the want of the felicity possessed by another, but because he enjoys it. Envy, in its nature and effects, is the basest, most mischievous, and most tormenting of all passions. Aristotle (*De Rhetor.* l. ii. c. 12.) observes, that this passion most usually affects persons who were once upon a level with those they envy. The method prescribed by Cicero (*De Orat.* l. ii. c. 52.) for lessening or removing the influence of this passion is to shew that the things which occasioned it, have not happened to the envied person undeservedly; but are the just rewards of his industry or virtue; that he does not so much convert them to his own profit or pleasure, as to the benefit of others; and that the same pains and difficulties are necessary to preserve them, with which they were at first acquired.

ENVY, in *Mythology*, is represented by the Greek and Roman poets as an infernal divinity, with squinting eyes, lean body, pale countenance, disturbed air, head encompassed with serpents, &c.

ENURNY, is the *herald's* term for the bordure of a coat of arms being charged with any kind of beasts.

ENXYLON, of *en* and *ξύλον*, *wood*, a name used by the Greek authors for a species of worm or maggot, hatched from the egg of a beetle, and having its habitation in wood; which, in this state, it erodes and burrows into, in various directions. The old Greeks called it also *dex* and *thrips*, and used the pieces of wood eroded by it in remarkable figures, as seals. See THRIPS.

ENY, SAINT, in *Geography*, a small town of France, in the department of La Manche; 9 miles S. W. of Carantan.

ENYDRA, in *Botany*, (*ενυδρος*, *living in the water*), a Syngenesious genus of Loureiro's *Fl. Cochinch.* 510, which appears to belong to the 4th section of Jussieu's *Corymbifera*, and to the order *Polygamia-segregata* of Linnæus. The character is, Common Calyx of four leaves; partial of one leaf, rolled up into a tube, single-flowered. Corollas all tubular; those of the radius three-cleft. Receptacle naked. Down none. The species is *E. fluvians*, a native of the marshes of Cochinchina, with opposite, serrated, rather hastate leaves, and a white terminal flower. We know not whether it be reducible to any previously-described genus.

ENYSTRON, of *en* and *ὄστρος*, *posterior*, a word used by Aristotle for the second ventricle in ruminating quadrupeds, in which the food is elaborated and concocted.

ENZ, in *Geography*, a river of Germany, which rises about 10 miles W. of Altenstadt, in the circle of Swabia,

passes by Wildbad, Neuenburg, Pfortzheim, &c., and joins the Neckar at Bessigheim, in the duchy of Wurtemberg.

ENZELLI. See EINZELLE.

ENZIG, a lake of Germany, in the circle of Upper Saxony, and new mark of Brandenburg; 12 miles W.S.W. of Dramberg.

ENZINAS, FRANCIS, in *Biography*, was born at Burgos, in Spain, about the year 1515. In Moreri and other works he is known by the name of Dryander, which is a Greek translation of his family name. He was educated in Germany, and became a zealous disciple of Melancthon, who thought very highly of his talents, and wrote a letter in his favour to archbishop Cramer in the year 1548. He published a Spanish translation of the New Testament, which he dedicated to the emperor Charles V.; and which drew down upon him the vengeance of the higher powers, and he suffered an imprisonment of 15 months duration. He escaped in the year 1545, and went to Calvin, who resided at Geneva. He published "A history of the State of the Low Countries, and of the Religion of Spain," which is very rare, and forms a part of the "Protestant Martyrology," printed in Germany.

ENZINAS, JOHN, brother of the former, resided a considerable time at Rome, and became a convert to the protestant religion, and was setting out for Germany to join his brother John, when some expressions which he dropped, relative to the corruptions and disorders of the church, occasioned his being accused of heresy, and thrown into prison. The terrors of a dungeon, and the prospect of a cruel death, did not daunt his noble soul, but when brought before the pope and cardinals to be examined, he refused to retract what he had said, and boldly avowed and justified his opinions, for which he was condemned to be burnt alive; a sentence which was put into execution at Rome in the year 1545. Moreri, under the word Dryander.

ENZOWAN, in *Geography*, a town of Bohemia, in the circle of Leitmeritz; four miles E. of Leitmeritz.

EO, EU, or *Miranda*, a river of Spain, which rises in the mountains of Asturias, separates the province of Asturias from Galicia, and runs into the Atlantic, a little to the north of Rivadeo.

EOA, in *Ancient Geography*, a town of Africa Propria, according to Ptolemy; called Oea by Mela.

EOBANUS, HELIUS, in *Biography*, an eminent Latin poet, was born, in 1488, on the confines of Hesse; hence he obtained the name of Hessian. His parents were so poor, that it has been said he was born in the open air under the shade of a wide spreading tree; but his education was not neglected. He was taught Latin at a small school, and pursued his more advanced studies at the university of Erfurt, where he afterwards taught the belles lettres till the year 1526, when Philip Melancthon procured him an invitation from the city of Nuremberg. Here he taught for seven years and then returned to Erfurt, where his reputation was so high and so firmly established, that he is said to have had 1500 scholars at a time. His fame produced him but very trifling emoluments, and he was often labouring under the greatest poverty. He at length obtained through the interest of Philip, landgrave of Hesse, a good situation at the university of Marburg, where he died on the 5th of October 1540. Camerarius, who wrote his life, praises his good qualities, his application to labour, and his talent at poetry. He was a man of great good nature, sincere in his attachments, and averse from contention. He took credit to himself for being a hard drinker, and would challenge any man as to the quantity of liquor which he would

drink, and in a contest of this kind his antagonist fell dead on the floor. He wrote many books, a list of which is given by Moreri: his poems and epistles have been frequently published. Moreri.

EODANDA, in *Ancient Geography*, a desert island, situated E. of Arabia Felix.

EOLIAN, in *Ancient Music*. The Eolian tone or mode was one of the mean or principal modes of the Greek music, and its fundamental sound was immediately above the Phrygian.

The Eolian mode was grave, according to Latus. "I sing (says he) Ceres and her daughter Melibæa, the spouse of Pluto, upon the Eolian mode, full of gravity."

The name of Eolian, given to this mode, is not derived from the Eolian isles, but from Eolia, a country of Asia Minor, where it was first used.

EOLIC, or rather *Æolic*. See *ÆOLIC*.

EOLIPILE. See *ÆOLIPILE*.

EOLUS, and *EOLUS's harp*. See *ÆOLUS*.

EON, or *ÆON*. See *ÆON*.

EON, a word used by some anatomical writers to express the whole ambit or compass of the eye.

EON, DE L'ETOILE, in *Biography*, a French fanatic, who, from the resemblance of his name to the word *eum*, applied to himself this passage, "per Eum qui venturus est judicare vivos et mortuos," and was satisfied that he was the person alluded to, viz. the son of God. This doctrine he taught with much fervour, and succeeded, like other enthusiasts, in making many converts, who gave him the homage due to one on whom their future destiny depended. At Rheims he drew down the notice of the clergy, who caused him to be apprehended, and after an examination he was committed to prison, where he languished a few days, and miserably died. Many of his adherents persisting in the same follies which had characterized their master, were apprehended, and, refusing to abjure their errors, were delivered over to the secular power, and were burnt alive in the neighbourhood of Rheims. Such was the persecuting spirit of the priests who never fail to abuse the power entrusted to them, and who would, in this instance, have been better employed in instructing their own flocks than in murdering these deluded fanatics. Moreri.

EOOA. See *EA-OO-WEE*.

EORDÆA, in *Ancient Geography*, a country of Macedonia, in Mygdonia.

EORIA, in *Mythology*, a feast celebrated by the Athenians in honour of Erigonus, who, by way of punishment, for their not avenging the death of his father Icarus, engaged the gods to inflict the curse on their daughters, that they should love men who never returned their passion. The feast was instituted by the order of Apollo.

EOSTRE, a Saxon goddess, to whom they sacrificed in the month of April, called the month of Eostræ; and thence the name Easter, which the Saxons retained after their conversion to Christianity, applying it to the festival celebrated in commemoration of our Saviour's resurrection. Bed. de Rat. Temp. cap. 13.

EPACRIA, in *Ancient Geography*, a town of Greece, in Attica.

EPACRIS, in *Botany*, from *επι*, upon, and *ακρῖς*, the summit of a mountain, alluding to the native situation of several of the species. Mountain-blossom. Forst. Gen. t. 10. Linn. Suppl. 19. Schreb. 113. Willd. Sp. Pl. v. 1. 834. Mart. Mill. Dict. v. 2. Gärtn. t. 94. Class and order, *Pentandria Monogynia*. Nat. Ord. *Erica*, Juss.

Gen. Ch. *Cal.* Perianth of several imbricated, ovate, acute leaves; the five innermost longest and equal. *Cor.*

of one petal, funnel-shaped; tube dilated upwards; limb in five equal, ovate, spreading segments. Nectary of five obovate blunt scales, closely surrounding the base of the germen. *Stam.* Filaments five, equal, very short, inserted into the summit of the tube of the corolla; anthers incumbent, roundish oblong, of two cells and two lobes, bursting longitudinally, destitute of any appendage. *Pist.* Germen superior, roundish, with five furrows; style cylindrical, rather shorter than the tube; stigma capitate. *Peric.* Capsule roundish, somewhat depressed, with five furrows, of five valves and five cells, the partitions from the centres of the valves. *Seeds* numerous, minute, angular, affixed to the central column.

*Eff. Ch.* Calyx imbricated. Corolla tubular. Stamens inserted into its orifice. Scales five, at the base of the germen. Capsule superior, of five cells and five valves, with partitions from their middle. Seeds numerous, chaffy.

The numerous species of this elegant genus, but few of which have, as yet, found their way into botanical books, are all natives of New Holland or New Zealand. They bear a general resemblance to the vast Cape genus *Erica*, with which botanists have associated them in natural order, not without some uncertainty. Willdenow enumerates but four species, of which the finest is *E. grandiflora*, Sm. *Exot. Bot. v. 1. 75. t. 39.* *Curt. Mag. t. 982.* (*E. longiflora*; *Cavan. Ic. v. 4. 25. t. 344.*) "Leaves heart-shaped, pungent, recurved, on footstalks. Flowers pendulous." Native of dry sandy places in New South Wales, flowering in October. Its chief beauty consists in its copious long pendulous flowers, with a crimson tube and white border.

To these are now added, *E. obtusifolia*, Sm. *Exot. Bot. v. 1. 77. t. 40.* "Leaves elliptic-lanceolate, very obtuse, and pointless, on short footstalks. Flowers drooping toward one side." Grows in a sandy soil near Port Jackson, New South Wales, blossoming in October. The flowers are cream-coloured, with a brownish calyx.

*E. pulchella*, *Cavan. Ic. t. 345.* *Curt. Mag. t. 1170.* Branches clothed with rusty down. Leaves heart-shaped, recurved, pungent. Flowers axillary, crowded. Native of Port Jackson. Flowers white, sweet-scented.

*E. pungens*, *Cavan. Ic. t. 346.* Branches smooth. Leaves ovate, pungent. Flowers axillary, crowded. Tube cylindrical. Common about Port Jackson. The flowers are copious, large, snow-white, and very fragrant, resembling those of a *Phlox* in size and figure. Cavanilles' plate, a truly miserable representation of this magnificent species, misled Dr. Sims in *Curt. Mag.* to confound it with the last. We apprehend this last writer has committed a further error in taking the red-flowered species, represented in his *t. 1199*, for a variety of the *pungens*. They seem to us very distinct.

Forster and Cavanilles confounded with the genus of *Epacris* that of *Styphelia*, whose fruit is a drupa, with five seeds.

EPACTHES, *Ἐπαχθῆς*, in *Antiquity*, a festival celebrated in honour of Ceres, named *Ἀχθῆα*, from *ἄχθος*, *i. e.* grief, in memory of her sorrow, when she had lost her daughter Proserpine.

EPACTS, in *Chronology*, the excesses of the solar month above the lunar synodical month; and of the solar year above the lunar year of twelve synodical months; or of several solar months above as many synodical months; and several solar years above as many dozen of synodical months.

The epacts, then, are either *annual* or *menstrual*.

EPACTS, *Menstrual*, are the excesses of the civil or calendar month above the lunar month.

Suppose, *e. gr.* it were new moon on the first day of January; since the lunar month is 29 days, 12<sup>b</sup> 44<sup>b</sup> 3<sup>o</sup>; and

the month of January contains 31 days; the menstrual epact is 1 day 11<sup>b</sup> 15<sup>b</sup> 57<sup>o</sup>.

EPACTS, *Annual*, are the excesses of the solar year above the lunar.

Hence, as the Julian year is 365 days 6', and the Julian lunar year 354 days 8' 48' 36", the annual epact will be 10 days 21<sup>b</sup> 11<sup>b</sup> 22<sup>o</sup>; that is, nearly 11 days. Consequently, the epact of two years is 22 days; of three years, 33 days; or rather three, since 30 days make an embolismic, or intercalary month.

Thus the epact of four years is 14 days, and so of the rest; and thus, every 19th year the epact becomes 0; consequently, the 20th year the epact is 11 again; and so the cycle of epacts expires with the golden number or lunar cycle of 19 years, and begins with the same, as in the following table; which is formed by the constant additions of 11, casting off 30; supposing the lunar month to consist of 29 and 30 days, and the civil year of 365 days, with a bissextile every fourth year. This natural order of the epacts is such as was established by the council of Nice, A.D. 325.

Gold. Numb.	Epacts.	Gold. Numb.	Epacts.	Gold. Numb.	Epacts.
1	XI	7	XVII	13	XXIII
2	XXII	8	XXVIII	14	IV
3	III	9	IX	15	XV
4	XIV	10	XX	16	XXVI
5	XXV	11	I	17	VII
6	VI	12	XII	18	XVIII
				19	XXIX

Again, as the new moons are the same, that is, as they fall on the same day every 19 years, so the difference between the lunar and solar years is the same every 19 years. And because the said difference is always to be added to the lunar year, in order to adjust or make it equal to the solar year; hence the said difference respectively belonging to each year of the moon's cycle is called the "epact of the said year," that is, the number to be added to the said year, to make it equal to the solar year, the word being formed from the Greek *ἔπαχος*, *induco*, *intercalo*.

Upon this mutual respect between the cycle of the moon and the cycle of the epacts, is founded this rule for finding the Julian epact, belonging to any of the moon's cycle. Multiply the year given of the moon's cycle into 11; and if the product be less than 30, it is the epact sought; if the product be greater than 30, divide it by 30, and the remainder of the dividend is the epact. For instance, we would know the epact for the year 1712, which is the third year of the moon's cycle. Wherefore 3 is the epact for 1712, for  $11 \times 3 = 33$ , and 33 being divided by 30, there is left three of the dividend for the epact. But the difference of the Julian and Gregorian years being equal to the excess of the solar above the lunar year, or 11 days, it happens that the Gregorian epact for one year is the same with the Julian epact for the preceding year.

By the help of the epact may be found what day of any month in any year the new moon falls on, thus: to the number of the month, from March inclusively, add the epact of the year given: if the sum be less than 30, subtract it out of 30; if greater, subtract it out of 60; and the remainder will be the day whereon the new moon will fall.

If the new moon be sought for in the month of January or March, then nothing is to be added to the epact; if for February or April, then only one is to be added.

## EPAMINONDAS.

Thebes was taken by the Lacedæmonians, and Pelopidas with others attached to liberty and independence were expelled, but Epaminondas was suffered to remain, as one whose poverty and philosophy would prevent him from taking any part in political concerns. When the exiles, about four years afterwards, regained the city, they were joined by Epaminondas, and the Thebans regained their liberty. These two friends concurred in improving the military discipline of their fellow-citizens; and Epaminondas in particular took pains by his counsel and example, in promoting among them that frugality and contempt of pleasure which lie at the foundation of all manly exertions. By such conduct he gained the confidence of the Thebans, and being raised to a high rank in the army, he was deputed as a delegate to Sparta for the purpose of negotiating a peace. On this occasion, when the other deputies were overawed by Agesilaus, who guided the operations of the Lacedæmonians, Epaminondas asserted the dignity of his character as the representative of an independent state, and insisted that the Thebans should retain the same authority in Bœotia with that of the Spartans in Laconia. The Spartan king was incensed, and war was immediately declared against the Thebans. The Lacedæmonians gave orders to their king Cleombrotus, to march into Bœotia at the head of an army consisting of 10,000 foot soldiers and 1000 horse. The army of the Thebans was made up of only 6000 infantry and a small body of cavalry; but Epaminondas commanded it, and under him was Pelopidas. The two armies met at Leuctra, a small town of Bœotia, and on the 8th of July, B.C. 371, a battle was fought, which by the wisdom and valour of Epaminondas terminated in the defeat of the Lacedæmonians, and the death of Cleombrotus. It afforded singular satisfaction to the victorious general that his father and mother had lived to witness the glory he now acquired. Two years after (B.C. 369) Epaminondas and Pelopidas were nominated Bœotarchs, or chiefs of the Bœotian league. The concurrence of circumstances, mutual esteem, friendship, and an uniformity of sentiments and views, formed an indissoluble union between these two great men. With Pelopidas, the companion of his labours and his glory, Epaminondas entered Peloponnesus, spreading terror and desolation through the states in alliance with Lacedæmon, hastening the defection of others, and breaking the yoke under which the Messenians had groaned for centuries. Seventy thousand men of different nations marched under his orders with an equal confidence, and he led them on to Lacedæmon. Agesilaus, apprised of his approach, was anxious and alarmed; but such was his resistance, and the delay occasioned by it, that Epaminondas thought it most prudent to retreat. After quitting the Spartan territories, he rebuilt the ancient city of Messene, and recalled its dispersed inhabitants from the surrounding countries, in which they had long lived as aliens. It was the established rule of the Bœotian league, that the chiefs should hold their office only for a year, and then resign to their successors. Epaminondas and Pelopidas, however, retained their authority four months longer than the term prescribed by law. For this they were accused, and judicially prosecuted. Pelopidas pusillanimously sunk under the charge; but Epaminondas appeared before his judges with the same tranquillity as at the head of his army, and thus addressed them: "The law condemns me, I merit death, I only demand that this inscription be engraven on my tomb: the Thebans have put Epaminondas to death, because at Leuctra he forced them to attack and vanquish those Lacedæmonians, whom they did not before dare to look in the face; because his victory saved his country, and restored liberty to Greece;

because under his command the Thebans besieged Lacedæmon, which deemed herself too fortunate to escape from ruin; and because he rebuilt Messene, and surrounded it with strong walls." The people present applauded this speech, and the judges did not dare to condemn Epaminondas. In the next year Epaminondas marched again into Peloponnesus to aid the Arcadians against the Spartans; and having taken some towns and laid waste the country, he marched to Corinth, which was successfully defended against him. Upon his return, so uncertain is popular favour, he was deprived of his command, and reduced to the condition of a private citizen. After some time, an army being sent to rescue Pelopidas, who had been seized and imprisoned by the tyrant Alexander the Phœæan, Epaminondas served in it as a private soldier, and in that humble rank preserved the army from being utterly destroyed. His fellow-citizens reinstated him in his command, and sent him with fresh forces to recover his friend, whose life was supposed to be in imminent danger. Alexander was so intimidated that he acquiesced in a cessation of arms, on condition of releasing Pelopidas and another deputy. Thebes had now arrived at such a degree of importance among the Grecian states, as to be preferred to Sparta and Athens by the Persians, who, therefore, wished to enter into a treaty with the Thebans. Pelopidas concluded the treaty, though the Theban allies demurred against it. Epaminondas was therefore deputed with an army to force the Achæans to continue the alliance; and in this business he succeeded, and a general peace soon followed. Epaminondas wished to render his country as powerful by sea as it was by land; and with this view he was deputed to negotiate with the Rhodians, Chians, and other maritime people. The Thebans were still pursuing their ambitious designs; and Epaminondas marched a powerful army into Peloponnesus: but, as a confederacy was formed against the Thebans, the troops of which assembled at Mantinea, Epaminondas, apprehending that Sparta would be left defenceless, made a sudden march in order to surprise it. But Agesilaus was ready to receive him. Informed by a deserter of Epaminondas's march, he returned home with extraordinary celerity, and placed his soldiers in the most important stations. The Theban general ordered several attacks. He had penetrated to the forum, and made himself master of one part of the city, when Agesilaus, then near 80 years of age, listening only to the dictates of despair, rushed into the midst of danger, and seconded by the brave Archidamus his son, repulsed the enemy and compelled them to retire. Epaminondas was not molested in his retreat; but a victory was become necessary, that the failure of his enterprise might be forgotten. He therefore marched suddenly to Mantinea, expecting to find it unguarded; but here he was disappointed. He determined, however, to risk a battle for the purpose of retrieving his honour. The army of the Lacedæmonians and their allies consisted of more than 20,000 foot and near 2000 horse; the army of the Theban league of 30,000 infantry and about 3000 cavalry. Never did Epaminondas display greater abilities than on the present occasion; so that the enemy, dismayed at his appearance, betook themselves to flight. But whilst he was pursuing them with great ardour, they suddenly rallied, and poured upon him a shower of darts. At length one of them pierced his breast with a javelin, the point of which was left in his body. When he was carried off the ground to his tent, and had recovered his speech, his first question was, what was become of his shield? when it was brought him, he kissed it as the instrument of his labours and his glory. He then inquired concerning the event of the battle; and being in-

formed

formed that the Thebans were victorious, he said, "It is well; I have lived long enough;" or, as others report his declaration, "I die unconquered. Advise the Thebans to conclude a peace." The javelin being then extracted, he expired, B. C. 363. Epaminondas was never married; and he seems to have regarded celibacy as most favourable to his philosophical pursuits in private life, and to his active services in a public station. On the plain where he fell, two monuments were raised to him, *viz.* a trophy and a tomb. Epaminondas is represented by Cicero as one of the greatest men that any age or nation ever produced: and why, it is said, should we not grant this honourable distinction to the general who perfected the art of war, who eclipsed the glory of the most renowned commanders, and who was never vanquished but by fortune; to the statesman, who gave to Thebes a superiority she had never possessed, and which she lost immediately upon his death; to the negotiator who, in the general assemblies and congresses of Greece, always maintained a superiority over the other Grecian deputies, and found means to retain in the alliance of Thebes, his country, even the states who were jealous of the growth of this new power; to the man who equalled in eloquence the greater part of the Athenian orators, was no less devoted to his country than Leonidas, and perhaps more just even than Aristides? Travels of Anacharsis, vol. ii. Corn. Nep. Vit. Epam. Plutarch Vit. Pelop. & Agesil. Univ. Hist. vol. v. and vi.

**EPANALEPSIS**, *Επαναληψις*, called also *Epanadiplosis*, in *Rhetoric*, the repetition of the same word in the beginning of one sentence, and at the end of another. Thus Virgil,

"Ambo florentes ætatis, Arcades ambo."

Such also is the expression of Plautus (*Amph. Act. ii. Sc. 2. v. 21.*): "Virtue contains all things: he wants no good thing who has virtue." The figure is the same, though the principle is less honest, which occasions the advice given by the writer in Horace, (*Epist. i. 1. 65.*) "Get money, if you can, honestly; but, however, get money." This figure adds force to an expression, when the principal thing designed to be conveyed is thus repeated, so as to leave its impression last upon the mind. And the beauty is heightened, when the sentence has an agreeable turn arising from two opposite parts; as in Cicero's compliment to Cæsar, (*Pro Marcell. c. 6.*): "We have seen your victory terminated by the war: your drawn sword in the city we have not seen." Hermogenes (*Sturm. de Univers. Eloc. p. 410.*) calls this a *circle*, because the sentence returns again to the same word. See *ANADIPLOSIS*.

**EPANAPHORA**, *Επαναφορα*, the same with anaphora.

**EPANA'STASIS**, (from *επι*, and *αυσισημι*, to excite,) in *Surgery*, a tumour, or tubercle.

**EPANASTROPHE**, *Επαναστροφη*, in *Rhetoric*, the same with what is otherwise called anadiplosis.

**EPANCYLOTUS**, (from *επι*, and *αγκυλος*, crooked), in *Surgery*, a bandage described by Oribasius.

**EPANODOS**, *Επανοδος*, in *Rhetoric*, an inversion of a sentence, or a repetition of the same words in an inverted order; thus:

"Nox brevis nimis, ah! nimis brevis nox." Voss. *Rhet. lib. v. p. 298.*

This figure comprehends both *anadiplosis* and *epanalepsis*; for it both begins and ends with the same word, and the same word is likewise repeated in the middle. This turn of expression has a beauty in it, and shews a readiness of thought. Minutius Felix has given an example of it, when he is exposing the folly of the Egyptian superstition. "Isis," says he, "with Cynocephalus, and her priests,

laments, bemoans, and seeks her lost son; her attendants beat their breasts, and imitate the grief of the unhappy mother: in a little time the son is found, upon which they all rejoice. Nor do they cease every year to lose what they find, or to find what they lose. And is it not ridiculous to lament what you worship, or to worship what you lament?" This figure serves likewise to illustrate and enforce the sense by setting it in two opposite views. Such is the expression of the prophet (*Is. v. 10.*) "Wo unto them, who call good evil, and evil good: who put darkness for light, and light for darkness."

**EPANORTHOSIS**, or **CORRECTION**, in *Rhetoric*, a figure by which the orator revokes and corrects something before alleged, as too weak, and adds something stronger and more conformable to the passion by which he is agitated.

The word is formed of *ορθος*, right, straight; whence *ορθωω*, I straighten; *ανορθωω*, *επανορθωω*, I redress, straighten, correct, and *επανορθωσις*, correction. Accordingly the Latins call it *correctio* and *emendatio*.

This figure is used in different ways. Sometimes one or more words are recalled by the speaker, and others substituted in their room. At other times, without recalling what has been said, something else is introduced as more suitable, instances of both kinds follow.

Such, *e. gr.* is that of Cicero for Cælius: "O stultitia! stultitiamne dicam, an impudentiam singularem? Oh folly! folly did I call it, or rather intolerable impudence?" And in the first *Catilinarian*: "Quamquam quid loquor? Te ut ulla res frangat? Tu ut unquam te corrigas? Tu ut ullam fugam meditare? Tu ut ullum exilium cogites? Utinam tibi istam mentem dii immortales donarent." Thus also Terence, in the *Heautontimo-rumenos*, introduces his old man Menedemus, saying,

"Filium unicum adolescentulum

Habeo. Ah! quid dixi habere me? imo habui, Chreme. Nunc habeam necne, incertum est." "I have an only son, Chremes. Alas! did I say, that I have? I had indeed; but it is now uncertain, whether I have or not."

Cicero, in his defence of Milo, speaking to the judges concerning Clodius says; "Are you only ignorant, what laws, if they may be called laws, and not rather torches and plagues of the state, he was about to impose and force upon us?" Again, in his defence of Plancius he says: "What greater blow could those judges, if they are to be called judges, and not parricides of their country, have given to the state, than when they banished him, who, when prætor, freed the republic from a neighbouring war, and when consul from a civil one?" Here he is speaking of Opimius: but in commending the moderation of Lucius Mummius who did not enrich himself, but his country, by demolishing the wealthy city of Corinth, he thus recalls his whole expression, and by giving it a new turn, heightens the compliment he designed him. "He chose rather," says he, "to adorn Italy, than his own house, though by adorning Italy his house seems to have received the greatest ornament." *De Off. l. ii. c. 22.* Sometimes the correction is made by substituting something contrary to what had been said before: as in the following passage of Cicero (*Philipp. iii. c. 2.*): "Cæsar" (meaning Augustus), "though but a youth, by an incredible and surprising resolution and courage, when Antony was most enraged, and we dreaded his cruel and pernicious return from Brundisium, at a time when we neither asked, nor expected, nor desired it (because it was thought impossible) raised a very powerful army of invincible veterans, to effect which he threw away his whole estate. Although I have

used an improper word; for he did not throw it away, but employed it for the safety of the government." At other times, as we have before observed, the correction is made by adding a more suitable word, without any repetition of the former. Thus Cicero, after he has inveighed against the crimes of Verres (lib. ii. c. 29.) breaks out into this pathetic exclamation: "O the clemency, or rather wonderful and singular patience of the Roman people?" The word *clemency* not being, in his apprehension, strong enough, he adds *patience*, as better answering his purpose. The sudden and unexpected turn of this figure gives a surprize to the mind, and by that means renders it the more pathetic.

EPANTHESMA, or EPANTHISMA, (from *επι*, and *ανθος*, a flower), in *Surgery*, an efflorescence; exanthema.

EPAPHÆRESIS, (from *επι*, importing a repetition, and *αφαιρησις*, a removal). In Galen it is employed in the sense of a repeated evacuation by bleeding.

EPARCHA, in the *Music of the Ancients*. Pollux, (Onomast. lib. iv. cap. 9.) tells us, that the eparcha was one of the strains of the Citharian mode, according to the division of Terpander. It was probably the prelude, for that is the signification of the word eparcha.

EPARCHUS, *Επαρχος*, an officer under the Greek emperors of Constantinople, who had the command of the guards, or government of a province.

EPARER, in the *Manege*, is used to signify the flinging of a horse, or his jerking or striking out with his hind legs: In caprioles, a horse must jerk out behind with all his force; but in ballottades he strikes but half out; and in croupades he does not strike out his hind legs at all. All horses that jerk are reckoned rude. See YERKING.

EPA'RGEMOS, (from *επι*, and *αργεμον*, signifying a white ulceration, or opacity of the eye), in *Surgery*, an epithet applied to a person affected with the disorder called argemon.

EPARITA, in the *Materia Medica*, a name given by Paracelsus to a sort of fine earth, of a liver colour, seemingly the same with the Tokay bole.

EPA'RMA, or EPA'RSIS, (from *επι*, and *αιρω*, to elevate,) in *Surgery*, a tumour of any sort. The term, however, is usually confined to a swelling of the parotid gland.

EPARRES, in *Geography*, a small town of France, in the department of the Îlère, near Vienne.

EPAULE, or ESPAULE, in *Fortification*, the shoulder of the bastion, or the angle made by the face and flank, otherwise called the angle of the epaule. See BASTION and ANGLE.

The word is pure French, and literally signifies *shoulder*.

EPAULE *en dedans*, in the *Manege*, a lesson of late invention, which, rendered into English, denotes that attitude in which, as the horse goes forward, he is so bent through his whole frame, that if he goes to the right hand, he must cross the right fore-leg over the left, and so *vice versa*; or, in the language of the Manege, his inner shoulder, or leg, over the outward. The old masters worked their horses upon circles, when they intended to supple the shoulders and haunches; but to this mode of working upon circles, it has lately been objected that it constrains the fore-part too much, and throws the horse upon his shoulders. To remedy this evil, M. de la Guerinierè, an accomplished horseman at Paris, invented the lesson called "epaule en dedans," and established it in his Manege. This new method, however, differs very little from the old practice, to which it owes its origin, and from which it is extracted and formed. The only objection against the circle is, that the horse, when worked circularly, has his haunches too much at liberty, by which means the weight of his body is thrown upon his

shoulders, which are thereby impeded in their motion; and the animal compelled to work in a manner directly opposite to what he should do. The blame, however, instead of being laid on the circle, should have been ascribed solely to the false and senseless manner in which horses were formerly worked in it; when heavy large bits and cavecons were used, with which the heads of horses were loaded, and brought down to a level with their knees, so that they carried them, like rams, when they fight, and batter one another with their foreheads. Had these old practitioners known the advantage, and, indeed, the necessity of raising the head, in order to press and bend the haunches, and of doing this by means of a snaffle with double reins, one being tied over the withers, on the opposite side to which the horse is to turn, the head would at once have been raised, the outward shoulder brought in, and the horse bent from nose to tail; but this discovery was reserved for sir Sidney Meadows, who has made many important improvements in the art of horsemanship. Berenger's Hist. &c. of Horsemanship. vol. ii.

EPAULEMENT. In treating of the enfilade, we had occasion to notice this part of the defences of batteries exposed to a flanking-fire. The designation is derived from the French word *epaule*, meaning "a shoulder," to which the epaulement bears a strong resemblance. Wherever a work, whether on the defences, or in the approaches of the besiegers, is subject to be enfiladed, and especially where that enfilade is *direct*, it becomes indispensibly necessary to raise an epaulement, for the purpose of warding off the shot. The thickness of such a buttress must always be proportioned to its height, which again must be carried up so far as may render the farthest gun, upon the battery to be secured, sufficiently safe from the ordinary *lobs* of shot fired en ricochet, as well as such as may enfilade by descent. A general rule may be easily formed; namely, that the epaulement should be full as thick as the parapet, be about ten feet, if practicable, beyond the prolonged line of the inner revetement of the terre-pleine, and be raised high enough to make an angle of ten degrees from the horizontal; the farther end of the battery being the angular point formed by the meeting of the terre-pleine, with a line drawn from the crest of the epaulement. If this proportion be properly attended to, it will be almost impossible to enfilade the defences with effect; because few ricochet shots, fired at an angle of ten degrees, will rise more than eight at their second flight. This mode gives a kind of standard, which proportions the height of the buttress to the length of the battery it is to protect.

Where there is space for such a work, it is often found highly advantageous to raise cavaliers at the extremities of the bastions, &c. which by their height serve as epaulements; but, as such defences, when they fall into the hands of the besiegers, not only afford a lodgment, but command the adjacent works, it is absolutely necessary they should be ruined; so that they may be completely annihilated whenever they are wrested from the defenders. It being a general rule, that the crest of the parapet should be full seven feet in height, very little elevation thereof will make a competent epaulement for a battery of small force, and especially where the cannon are placed as close up to the flank as circumstances may admit. This cannot be done so easily in salient angles which are acute, that is, under  $90^{\circ}$ ; but, in the flanked angles of bastions, &c. is generally very practicable. In the batteries and places of arms constructed by the besiegers, the epaulements may be made within ten feet of the outer cannon, and may be run up to any height, provided they do not obstruct the operations of other batteries; which, indeed, can be the case only in very peculiar situations.

situations. The best engineers recommend, that the epaulement should be merely temporary, except at the orillons on the extremities of the flanks of bastions, where they are always requisite to prevent such shots as may pass over the proximate bastion, when its angle or face may be battered, from enfilading the battery or the face of that bastion next to such orillon. When made on emergency, sand bags are found to answer admirably in the construction of epaulements; but when intended to be permanent, the buttresses should be made of the firmest soil, well compacted, and properly gazoned (*i. e.* turfed.) As we have remarked, while speaking of enfilades, no masonry should be exposed in the construction of epaulements any more than in traverses and parapets; on account of the incalculable mischief done by the numerous splinters which are knocked off by such shots as strike thereon.

**EPAULETTE**, is a distinguishing ornament, worn upon the shoulders of commissioned and of non-commissioned officers of some descriptions. The epaulette is always made to correspond in colour with the bindings and lace of the uniform: therefore where yellow binding is in use, gold embroidery, &c. are employed, and where white binding is adopted, silver embroidery only is suitable. The military service is by no means uniform in this ornament, some being epaulettes of one, some of another pattern; according to the fancies of the commandants respectively. The general rule is, that all general and field officers, as well as all superior staff officers, wear two epaulettes, the rest of the officers in a corps wearing but one. Though, as above stated, variety obtains, yet the generality consist of a rich strap, of gold or silver lace, cushioned below, to give it a square appearance upon the shoulder, and ornamented at its lower extremity with rich bullion, and fringe of a corresponding description; the upper end ordinarily fastens under, or on the cape, to a button; some being moveable, for the purpose of admitting a belt to pass underneath. The flank companies, *i. e.* the grenadiers and light infantry, generally wear wings, not altogether unlike crescents as they sit on the shoulder; of these the edges are ornamented with shorter bullions and fringe than are used in epaulettes. Some wings have shoulder-straps, others have none; and some are ribbed, or striped with narrow lace; but the generality are plain. In the navy, only large gold epaulettes are worn; all captains having two, and all under that rank but one. Formerly shoulder-knots, precisely resembling those in use among servants, were worn by many corps, especially the artillery. These originated in the use of chains, suspended from the collar down the arms, for the purpose of warding off the cuts of fabres; but they ultimately became merely decorative, and were from that period made of silver cords, plaited, looped, and tagged, which hung down generally in front of the shoulder. For the same purpose of defence, the cavalry have in some instances adopted a laminated epaulette, consisting of metal plates of various patterns, but commonly circular or oval, overlapping each other a little, so as to allow due play to the limb, yet forming no slight resistance against a fabre. It cannot be expected, that the shoulder should altogether escape injury, even though the edge of the weapon should be averted; since the ordinary force of an attempt to cut down the shoulder must prove extremely painful, and generally benumb the part for a while; or eventually cause a bruise of some consequence.

It is evident, from what we have detailed, that the epaulette may be considered as the type of a certain portion of armour, in use not many years ago; but which has become less necessary since discipline has empowered infantry to resist cavalry; and as the former laid aside their broad-swords in

déference to the adoption, and to the superiority of the musquet and bayonet.

Though, in some parts of the British service, the corporals still wear short shoulder-knots, and the serjeants retain their epaulettes, both being of cotton, worsted, or silk, the generality of them now wear the distinguishing marks of their respective ranks, in the form of fleches, or angular lacings on their sleeves. Some variation exists in this particular, according to the nature of their employ; but, in general, one, two, and three fleches are the ordinary indications of rank. Thus, where an order of merit is established among the privates, such as appertain thereto wear one fleche, the corporals having two, and the serjeants three. This mode does not, however, seem to carry so much notoriety with it as the epaulette, which can be seen both from before and from behind the individual wearing it; whereas the fleche can be distinguished but in one particular point of view.

**EPEE**, in *Geography*, a port of Africa, in the country of Benin.

**EPEMBOLE**, Επεμβολη, in *Rhetoric*, the same with parembolē.

**EPENCRANIS**, a name by which some of the old authors, particularly Erasistratus, have called the cerebellum.

**EPENDYTES**, Επειδυτες, among the Greeks, a garment worn under the pallium, and above the interula or inner coat, called, in Greek, ἑπειδυτης.

**EPENTHESIS**, formed of επι, εν, and τεθημι, *q. d.* επενθημι, *infero, immitto*, in *Grammar*, the addition, or insertion of a letter or syllable, in the middle of a word; as *relligio* for *religio*, *Mavors* for *Mars*, *alituum* for *alium*. Virg. *Æn.* lib. vii. ver. 27.

In the Hebrew language, there are some letters which are called *epenthetic*, and they occur without any apparent necessity in the middle of words; such are יןן. Masclaf's Heb. Gram. v. i. p. 191.

**EPERIES**, in *Geography*, a town of Hungary, celebrated for its mines of salt; 20 miles N. of Caschau.

**EPERLANUS**, in *Ichthyology*, a name sometimes given, on account of its pearl colour, to the smelt. See *SALMO Eperlanus*.

**EPERLEQUE**, in *Geography*, a town of France, in the department of the Straits of Calais; 2 leagues N.W. of St. Omer.

**EPERNAY**, or **ESPERNAY**, an ancient and handsome town of France, in the department of the Marne, chief place of the district of the same name, with a population of 4430 individuals. It is pleasantly situated on the river Marne, 21 miles N.W. of Châlons sur Marne, 18 miles S. of Rheims, and 88 miles E. by N. of Paris. N. lat. 49° 2'. The canton has a territorial extent of 110 kilometres, 11 communes, and 13,958 inhabitants.

As chief place of a district, Epernay has a sub-prefect, a ranger, a court of justice, and a register office. There are several manufactures of woollen stuffs, hosiery, cutlery, leather, and writing-paper; but the most remarkable is that of a sort of glazed earthen-ware, which stands the hottest fire.

The district of Epernay has 10 cantons, 215 communes, and 87,413 inhabitants, on a territorial extent of 2592½ kilometres. Its soil is uncommonly fertile, and produces corn, but especially that excellent red and white champaign of the very first quality, which is so much sought for all over the world. Epernay is the centre of the best champaign wines; its own vineyards and those of Ay produce the best; and the town has a great trade not only with

these, but also with the famous wines of the hills of Hautvilliers, Pierry, and Cumieres, which are not far distant.

EPERNON, a town of France, in the department of the Eure and Loire; 4 leagues N.E. of Chartres.

EPERON, in *Natural History*, the spur-shell, so called from its resembling, in some degree, the rowel of a spur. It is a species of snail, of the round-mouthed kind, or class of the cochleæ lunares; all its volutæ are surrounded with double rows of prickles. See LUNARIS *Cochlea*.

EPERONNIER, in *Ornithology*. See PAVO *Bicalcaratus*.

EPERUA, in *Botany*. See DIMORPHA.

EPERVIER. See FALCO.

EPERVIERS, in *Natural History*, a name given by the French authors to a class of butterflies, which make the sixth in Reaumur's method. They have a way of poizing themselves on the wing in the manner of kites, and other birds of prey; and always live upon the wing, never settling themselves upon the flowers they feed upon, but keep flying with a humming noise like a humble bee, while they thrust in their trunk and suck the juices of the flower.

EPETIUM, in *Ancient Geography*, a town of Illyria, on the coast of Dalmatia, between Salone and Pagentium, near the mouth of a river, now called Xarnouvra. The town which has succeeded to Epetium is named *Sirobez*.

EPHA, a dry measure in use among the Hebrews.

The epha was the most common measure they used, and that whereby the rest were regulated. It is commonly supposed that the epha, reduced to the Roman modius, contained four modii and a half. Now the Roman modius of grain or flour contained twenty libræ or pounds, consequently the epha weighed ninety pounds. Dr. Arbuthnot reduces the epha to three pecks three pints, English measure. See MEASURE.

EPHALGIA, in *Ancient Geography*, now *Elpisura*, a town of Asia, in Mesopotamia, upon the banks of the Euphrates, W.N.W. of Circesium.

EPHEBÆUM, Εφῆβαιον, in *Antiquity*, the place where the ephēbi or youth exercised; or, as some say, where those who designed to exercise met, and agreed what kind of exercise they should contend in, and what should be the victor's reward.

EPHEBI, Εφῆβοι, among the Athenians, a designation given to their young men when they arrived at eighteen years of age, at which time they had their names entered in a public register. Pott. *Archæol. Grec. lib. i. cap. 9. tom. i. p. 48.*

EPHEDRA, in *Botany*, (εφεδρα is an ancient name for a climbing or parasitical plant, and expresses a sitting upon any thing; hence it seems to allude to the squat or decumbent and crowded habit of this shrub.) Sea side Grape. Linn. Gen. 532. Schreb. 707. Willd. Sp. Pl. v. 4. 858. Mart. Mill. Dict. v. 2. Juss. 411. Class and order, *Dioscia Monadelphica*. Nat. Ord. *Conifera*.

Gen. Ch. Male, *Cal.* the scales of a catkin, few, single-flowered, roundish, concave, each the length of the perianth, which is of one leaf, cloven half way down, roundish, inflated, compressed, small and blunt. *Cor.* none. *Stam.* Filaments seven, united into an awl-shaped column, cloven at the top, and longer than the calyx; anthers roundish, turned outwards, four of them below the rest. Female, *Cal.* Perianth five-fold; one placed upon another so that their segments are alternate, forming an ovate figure; each is nearly ovate, of one leaf, cloven, the outer or lower ones smallest. *Cor.* none. *Pist.* Germens two, ovate, the size of the innermost perianth on which they stand; styles two, simple, thread-shaped; short; stigmas simple. *Peric.* none.

except the perianths, all become succulent and thickened; constituting a divided berry. *Seeds* two, ovate, acute, convex on one side and flat on the other, compressed by the perianth which incloses them on every side.

Ess. Ch. Male, Calyx the scale of a catkin, in two segments. Corolla none. Stamens seven. Anthers four inferior; three superior. Female, Calyx cloven, five-fold. Corolla none. Pistils two. Seeds two, inclosed in the pulp calyx.

The species known are but two.

1. *E. distachya*. Linn. Sp. Pl. 1472. Duhamel Arb. t. 92. (*Uva marina*; Ger. emac. 1116. f. 1, and 1117. f. 2.) "Flower-stalks opposite. Catkins in pairs." Native of various parts of the south of Europe, in a sandy soil about the shores of the sea or of lakes, flowering in June and July. It bears our climate, especially if led upright against a wall. A fine bush of this kind may be seen in the Oxford garden, ten or twelve feet high. It is a bushy, smooth, leafless shrub, always green, with the habit of an *Equisetum*. The catkins are yellowish. *Berries* scarlet, sweetish, viscid, eatable but not agreeable.

2. *E. monostachya*. Linn. Sp. Pl. 1472. (*E. polygonoides*; Pall. Ross. v. 1. t. 83.) "Flower-stalks several. Catkins solitary." Native of Siberia. Linnæus suspected this to be only a variety of the last, and Pallas confirms his opinion.

EPHELÆUM, in *Anatomy*, is the place from the hypogastrium, or lower part of the abdomen, to the secret parts.

EPHELICIS, from επι, and ἔλκος, an ulcer, in *Surgery*, a scab, or crust, upon a sore.—Also, a small portion of blood, voided by coughing.

EPHELIS, from επι and ἥλιος, sun, a name used by the ancient writers on *Medicine*, for a disorder of the face, brought on by the sun and drying winds, and of the nature of what we call sun-burning. It was a certain roughness, hardness, and bad colour of the skin.

The ephelis, or sun-burning, is removed by an application of resin, to which a third part of fossil salt, and a little honey are added; but all these disorders, as also the unnatural colour of cicatrices, are remedied by the following preparation, ascribed to Trypho the Elder:

Take equal quantities of myrobolans, crocomagna, cimolian earth of a blueish colour, bitter almonds, the meals of barley and bitter vetch, dyer's weed (*Struthium album*); all these are to be triturated together, and made up with the most sharp honey. With this preparation the parts affected are to be anointed at night; and the medicine carefully to be washed off the next morning. James Med. Dict. See FRECKLES.

EPHEMERA, from ἐπι and ἡμερα, a day, in *Medicine*, the name given by the Greek writers to the mildest form of fever, which runs through its course within the period of one day. By the Romans the same fever was termed *diaria*, from *dies*, a day.

A fever which terminates in the course of twelve, eighteen, or twenty-four hours, is not a common occurrence in this climate; unless the slight disturbance of the system, which fatigue, repletion, a sleepless night, &c. induce, is to be called an ephemeral fever: and such, indeed, appears to be the disorder to which the term *ephemera* has been applied by writers in general, and which constitutes the *ephemera simplex*, or *legitima*, in their nomenclature. When the febrile condition is more severe, and therefore of longer duration, extending to the third or fourth day, by a solecism in language, it has been denominated *ephemera extensa*, or *ephemera plurimum dierum*. Any slight fever, of three

## EPHEMERA.

or four days duration, is occasionally called an ephemerata at present; the slight derangement of the habit, from the operation of the causes just mentioned, being scarcely deemed a disease worthy of a distinct appellation.

The ephemerata simplex is a slight febrile paroxysm, marked by languor, loss of appetite, thirst, headache, and slight pains in the limbs, with some heat of skin terminating in a gentle perspiration, and with dryness of the tongue and fauces. These symptoms, from their mildness, imply a very slight derangement of any of the functions of the body: they originate from some evident cause of disorder in what have been absurdly termed the non-naturals, and cease spontaneously when the influence of these causes no longer operates. The mildness of the symptoms, and the nature of the evident causes, are mentioned as the principal means of discriminating the ephemerata from the various forms of continued fever at their commencement. Among the causes of the ephemerata are enumerated the various passions of the mind, when strongly excited, as grief, anger, joy, or care and anxiety, likewise loss of sleep, excessive heat of the weather, fatigue from labour or exercise, a fit of intoxication or of repletion, sudden exposure to cold, fasting, too great evacuations, &c. It is admitted, indeed, that many of these causes occasionally give rise to continued fevers of long duration; but, in these cases, the attack is preceded by cold chills and shiverings, by languor and lassitude, loathing of food, &c. and is accompanied by more severe disorders of the functions, as by violent headache, pains in the back and limbs, nausea or vomiting, with great anxiety and restlessness. The presence or absence of these symptoms, in the commencement, will enable us to anticipate the future progress of the disease, whether it will be a mere ephemerata or a more serious continued fever.

Besides the simple ephemerata, arising from the causes already enumerated, which Sauvages has included under the four heads of ephemerata plethorica, ephemerata nauseativa, ephemerata à frigore, and ephemerata à calore, those slight febrile derangements, connected with bruises, dislocations, parturition, congestion of milk in the breasts, dysmenorrhœa, &c. have been also designated by the term ephemerata; which, in this case, is a secondary or symptomatic ephemerata. Avicenna, among the ancients, and Forestus, among the modern physicians, have made a still more extensive division of ephemerata; namely, into as many species as there are evident causes which induce it. Hence they uselessly distinguish ephemerata from grief, from joy, from hope, from fear, from thirst, from fasting, &c.

The original signification of the term implied a completion of all the stages of a fever, *viz.* the beginning, increase, acmè, and decline, (in the language of the ancients,) within the compass of a natural day. By this definition, Van Swieten observes, the most acute fevers, which often kill a patient in twenty-four hours, are excluded from the term; since they do not arrive at their declension in that space of time, although they end in death. Yet Caius has described that fatal epidemic, the *sweating sickness*, or *sudor Anglicus*, under the term of ephemerata; because, on the one hand, it often terminated in the space of twenty-four hours, by destroying the patient; and, on the other, by a sweating, continued for the same space of time, the patients were often cured. But in this case, though immediate danger was removed, yet great debility and other injuries to the functions still remained, for some time afterwards; so that the disease belonged to the class of continued malignant fevers. This disease, under the appellation of ephemerata sudatoria, constitutes the seventh species of Sauvages. It has been also denominated ephemerata Bri-

tannica, ephemerata maligna, ephemerata Anglica pestilens, &c. See SWEATING *Sickness*.

With respect to the cure of the ephemerata fever, little remains to be said. The term implies that its natural termination will occur within the period of a day, if left to itself: we here speak of the simple ephemerata, arising from a slight temporary cause. Abstinence alone, or the most light and slender diet, with diluent drinks, is all that is required. The bowels may be opened by gentle aperients, as neutral salts, infusion of fenna, &c.: and this ought not to be omitted, where the disease has arisen from over-repletion, or intoxication; in which case, it will contribute directly to remove the exciting cause of the disorder. Thin drinks, such as spring-water, or barley-water, acidulated or not with the juice of lemons, tea, or the infusions of other grateful herbs, may be used, and animal food abstained from.

The same treatment will be useful in the secondary or symptomatic forms of ephemerata; in which cases, however, the cure or alleviation of the original disorder must be the first step towards removing the ephemerata. See Galen Method. Medend. lib. viii. De Febris, lib. i. &c. Van Swieten, Comment. App. 728. Burferius Instit. Med. tom. i. sect. 198. Sauvages Nos. Meth. class. ii. genus 1.

EPHEMERA, in *Entomology*, a genus of the neuroptera order. This genus has the mouth destitute of mandibles; feelers four, very short, and filiform; jaws short, membranaceous, cylindrical, and connected to the lip; antennæ short and subulate; stemmata too large above the eyes; wings erect; the lower smaller; tail terminating in bristles.

The ephemeræ are proverbially a race of beings destined to enjoy the functions of life for a much shorter period than any other animals. This is a popular opinion, and, in a partial view of their history, not altogether incorrect; but it must be understood only of the last or winged state, after attaining which they exist but for a few hours. The duration of this period varies in different species. It is devoted solely to the pleasures of fulfilling the ordinary purpose of nature, the propagation of their kind; in the accomplishment of which the ephemeræ may be observed in myriads, during the summer season, sporting on the wing, just above the surface of the water. In the larva and pupa states the ephemeræ live one or two years; and some species, it is believed, live even three years from the time of hatching from the egg state, before they arrive at the perfect form. The larvæ are found in the water, wherein they constantly reside, and are the favourite food of fishes. They are active, furnished with six legs, a tail, six lateral fins or gills, and prey on smaller insects. The pupæ, like the larvæ, are carnivorous, and resemble the former state, except in having the rudiments of the wings apparent. The ephemeræ are so abundant in some countries, that they are used for the purpose of manure, the species vulgata especially. This is the common practice with the husbandmen in Carniola. They are also very numerous on some parts of the Rhine, the Maes, and Ifel. The season of their appearance in such multitudes continues, however, only for about three days annually. The ephemeræ are arranged in two sections, according to the number of bristles at the extremity of the tail.

### Species.

\* Tail with three hairs or bristles.

VULGATA. Wings reticulated, and spotted with brown; body yellowish, spotted with black. Scop. Donov. Brit. Ins., &c.

Inhabitants

Inhabits watery places throughout Europe.

**LUTEA.** Wings transparent, reticulated; body yellow. Fabr.

Native of Europe, and is found in Britain.

**MARGINATA.** Wings white; exterior margin fuscous; body black. Fabr.

Similar to *E. vulgata*, but smaller.

**VESPERTINA.** Wings black; posterior ones white. Linn.

Native of Sweden, and other parts of Europe.

**HALTERATA.** Wings two, white; abdomen whitish, with fuscous tail. Fabr. *Phryganca cauda trifida*, &c. Degeer.

Inhabits stagnant waters in the north of Europe.

**INANIS.** Wings hyaline; body black; segments of the abdomen from the fourth to the seventh pellucid. Linn.

Native of Europe.

**MAROCCANA.** Wings white, immaculate; body yellowish. Fabr.

Found in Morocco.

**BREVICAUDA.** Wings two, cinereous, with a black rib; abdomen pale; tail brown. Fabr.

A small species, found in the vicinity of Paris.

\*\* Tail with two hairs or bristles.

**BIOCULATA.** Wings white reticulated; head with two yellow tubercles; tail yellow. Fabr. Geoff., &c.

Native of European waters.

**RENSA.** Wings white reticulated; body brown. Fabr. Inhabits Denmark.

**NIGRA.** Body black; wings blackish; posterior pair very small. Linn.

Described by Linnæus as a native of Sweden; also inhabits other parts of Europe.

**CULICIFORMIS.** Wings white; body brown. Linn.

Found in Greece by Pada; also in Sweden by Linnæus, and in France by Geoffroy.

**HORARIA.** Wings white; thicker-margin blackish. Linn. *Ephemera minima*, Swammerdam.

Very abundant in Europe.

**STRIATA.** Wings hyaline, striated; thorax fuscous; abdomen white. Fabr. *Ephemera mutica*, Linn. Fn. Suec.

An European species.

**DIPTERA.** Wings two; costal margin brown, with cinereous spots. Linn.

The abdomen in this insect is marked with red lines. The species inhabits Sweden.

**FUSCATA.** Wings hyaline; abdomen brown, with the base whitish; legs pale. Fabr.

**ALBIPENNIS.** Wings white, immaculate; abdomen pale at the base; tail blackish. Fabr.

This and the preceding inhabit France, and other parts of Europe.

**NOTATA.** Yellow; wings white; abdominal segments with a fuscous spot each side. Linn.

*Ephemera notata* and the three following are inhabitants of watery places in Europe.

**TESTACEA.** Wings brownish; body brown testaceous; soles of the feet fuscous. Linn.

**FERRUGINEA.** Wings yellowish; body ferruginous. Linn.

**STIGMA.** Wings brownish; body pale yellow; thighs with a black dot in the middle.

**EPHEMERA**, is also applied among *Botanists*, to a kind of flowers which open and expand themselves at sunrise, and wither or close up again at his setting. Such are the dent-de-lion, vulgarly dandelion, and divers others.

**EPHEMERIDES**, in *Astronomy*, tables calculated by astronomers, shewing the present state of the heavens for every day at noon; that is, the places wherein all the planets are found at that time.

It is from these tables that the eclipses, conjunctions, and aspects of the planets are determined; horoscopes, or celestial schemes, constructed, &c.

We have ephemerides of Regiomontanus from 1475 to 1506, of Engel from 1494 to 1500, of Staefler from 1499 to 1531, of Origan from 1595 to 1654, of Kepler from 1617 to 1628, of Argoli from 1620 to 1700, of Heckerus from 1666 to 1680, of Wing from 1652 to 1671, of De la Hire from 1701 to 1703, of Manfredi from 1715 to 1750, of Parker, &c. S. Cassini has calculated ephemerides of the sidera medicæ, or satellites of Jupiter, which are of good use in determining the longitude.

In England the Nautical Almanac or Astronomical Ephemeris, published annually by anticipation, under the direction of the Commissioners of Longitude, is the most considerable. See **ALMANAC**.

In France they have preserved in the national library ephemerides of 1442; and celestial ephemerides have been published by M. Desplaces every ten years, from 1715 to 1745: they were afterwards continued by the abbé Caille, with many additions, from 1731 to 1774, of which an account may be seen in the History of the Academy of Sciences for 1743, &c.; they were further continued by Lalande from 1775 to 1810. The Academy of Sciences have likewise published annually, from the year 1678, a kind of ephemeris, under the title of *Connoissance des Temps*. This has been continued since the revolution under the direction of the "Bureau des Longitudes." The two volumes for the years 8 and 9, edited under the inspection of M. Lalande, contain, besides other important articles, new catalogues of the stars; tables of the moon's horary motion by Delambre; observations of Mercury by Vidal, &c. They have also ephemerides at Bologna; those for 23 years from 1787 to 1810, being computed by C. Mateucci, assisted by Molani, Guglielmini, Sacchetti, Zanotti, and Canterzani. The ephemerides of Milan contain the result of an important labour of C. Oriani, on the method of correcting the elements of the tables of Mercury by observation, and many interesting observations of C. Reggio and De Cesaris, &c. &c. The ephemerides of Berlin are now conducted by M. Bode, and contain many astronomical observations and memoirs by German, French, and English astronomers. The astronomers of Vienna commenced a similar work in 1757. The geographical ephemerides, undertaken by M. Von Zach, of Gotha, at the commencement of the year 1798, contain many curious observations; information respecting new books and charts, new voyages and geographical maps, portraits of eminent philosophers, and, in a word, every thing that can be interesting to astronomers, geographers, and navigators. The meteorological observations of the electoral Academy of Sciences at Manheim, from 1781 to 1792, are comprehended in 12 volumes 4to. under the title of "*Ephemerides Societatis Meteorologicæ Palatinæ*."

**EPHEMERUM**, in *Botany*, from *επιμερος*, lasting but a day, in allusion to its transient blossoms; see **LYSIMACHIA**. The name has also been given in ancient times to the hemlock, on account of the celerity of its destructive action upon animal life.

**EPHESIA**, in *Mythology*, a feast instituted at Ephesus, in honour of Diana.

**EPHESIANS**, **EPISTLE** to. See **EPISTLE**.

**EPHESIORUM PORTUS**, in *Ancient Geography*, a port

port of Asia Minor, upon the Bosphorus of Thrace; the modern name of which is *Aphestiati*.

EPHESIUM, the name of a plaster, which is described by Celsus.

EPHESIUS, in *Biblical History*, a manuscript of the gospels written in 1166, and formerly in possession of a bishop of Ephesus, whence it has taken its name. It is noted 71 in the first part of Wetstein's N. T. It is at present in the archbishop's library at Lambeth, to which it was presented by Trahern, together with the extracts which he had made from it. These were inserted by Mill, in his collections of readings.

EPHESTIA, in *Mythology*, a feast celebrated in honour of Vulcan, in which three young lads ran for a prize.

EPHESTRIA, were feasts celebrated at Thebes, in honour of Tyresias.

EPHESUS, in *Ancient Geography*, a city of Asia Minor, in Ionia, formerly reputed the metropolis of Asia. Stephanus styles it "Epiphaneſtata," or most illustrious. Pliny represents it as the ornament of Asia; and Strabo describes it as the largest and most frequented emporium of that continent. The ancient city, which was originally a small village, stood about 50 miles S. of Smyrna, near the mouth of the river Cayster, and the shore of the Icarian sea, which is a bay of the Ægean; but its precise situation cannot be ascertained, as it was often destroyed and rebuilt. Some modern travellers maintain that the ancient city stood more to the south than the present town, or rather village, which they infer from the ruins that still remain. It was known in ancient times by the names of Alopes, Ortygia, Morges, Smyrna, Trachæa, Samornion, and Ptela. Its name Ephesus is derived, according to Heraclides, from the Greek word *ephefus*, signifying permission; because Hercules, as he says, permitted the Amazons to live and build a city in that place. Others allege, that Ephesus was the name of the Amazon that founded the city: for Pliny, Justin, and Orosius unanimously affirm, that it was built by an Amazon; while others ascribe the honour to Androclus, the son of Codrus, king of Athens, who was the chief of the Ionians that settled in Asia. However this be, it is acknowledged, that the city, which in the Roman times was the metropolis of Asia, was founded by Lyſimachus; who, having caused the ancient city to be demolished, rebuilt a new one, at a vast expence, in a place more convenient, and nearer the temple. We learn from Strabo, that when the inhabitants manifested a reluctance to quit their ancient habitations, this prince caused all the drains, that conveyed the water into the neighbouring fens and the Cayster, to be privately stopped up: so that the city on the first violent rains that fell was in great part laid under water, and many of the inhabitants were drowned: and he thus constrained those who remained to retire into the new city. This new Ephesus was greatly damaged by an earthquake in the reign of Tiberius, but that emperor repaired and adorned it with several stately buildings, of which there are now some few ruins that testify its existence. The aqueduct, of which a part still subsists, is generally believed to have been the work of the Greek emperors; the pillars, that support the arches, are of fine marble, and they are higher or lower as the level of the water required. This aqueduct served to convey water into the city from the spring of Halitæe, mentioned by Pausanias. The gate, now called for some unknown reason the gate of persecution, is remarkable for three bas-reliefs on the mould, of exquisite taste. The port, of which many medals have been struck, is at present merely an open road, and not much frequented. The Cayster was formerly navigable, and afforded a safe place for

ships to ride in, but it is now almost choaked with sand. Ephesus is now venerable for nothing but the ruins of palaces, temples, and amphitheatres. It is called by the Turks *Ajafaluk* (which see), or the temple of the moon, from the magnificent structure formerly dedicated to Diana. The church of St. Paul, said to have been founded by the apostle, is wholly destroyed; the little which remains of that of St. Mark is sinking to ruin. The only church remaining is that dedicated to St. John, who resided here, and this is now converted into a Turkish mosque. The town is merely a miserable village, the habitation of herdsmen and farmers, living in low and mean huts, sheltered from the extremities of weather by mighty masses of ruinous walls; the pride and ostentation of former days, and the emblem in these of the transient vanity of human glory. All the inhabitants of this once famous city amount not to above 40 or 50 families of Turks, without one Christian family among them; so strikingly hath the scripture denunciation been fulfilled, that "their candlestick should be removed out of its place."

The ancient city, whether it was first built by Androclus, who conducted the Ionians hither and drove out the Carians and Leleges, by whom this situation was occupied before his arrival, or by one Cræſus or Ephesus, long before the Ionic migration, as others maintain, became soon the metropolis of Ionia. It was at first governed by Androclus and his descendants, who assumed the royal title, and exercised regal authority over the new colony; whence, even in Strabo's time, the posterity of Androclus were styled kings, and allowed to wear a scarlet robe, with a sceptre, and all the ensigns of royal dignity. In process of time, a senate was established and a new form of government introduced, which continued to the time of Pythagoras, who lived before Cyrus the Great, and was one of the most savage tyrants whose name and character history records; for having expelled the senate and engrossed the whole power, he filled the city with blood and rapine, not sparing even those who fled for shelter to Diana's temple. His successor Pindarus governed the city with a milder sway; and in his time Ephesus was besieged by Cræſus, king of Lydia, who advised the inhabitants to devote their city to Diana, and in consequence of their following his counsel, treated them with kindness, and restored them to their former liberty. The other tyrants of Ephesus, mentioned in history, are Athenagoras, Comes, Aristarchus, and Hegesias; the last of whom was expelled by Alexander, who, having defeated the Persians on the banks of the Granicus, bestowed upon Diana all the tributes which the Ephesians had paid to the Persians, and established a democracy in the city. After his death, this city became the prey of his successors. Lyſimachus took it, and afterwards Antigonus had possession of it and plundered it. Ephesus for a little while was restored to its ancient splendour; but it was always subject to the kings of Syria. In the war between Mithridates and the Romans, the Ephesians took part with the former, and by his order massacred all the Romans that resided in the city; for which barbarity they were severely fined, and reduced almost to beggary by Sylla, but afterwards treated kindly and suffered to live according to their own laws. It was under the reign of the emperor Alexius, father of Anne de Comnena, that the Mahometans made themselves masters of Ephesus. The Greeks retook it in 1206, but they lost it again 1283. At the commencement of the 14th century it became a part of the Turkish dominions; and both the place itself and its vicinity exhibit melancholy traces of indolence and inactivity. The Ephesians were much addicted to superstition, forcery, and curious arts, as the Scripture styles them (*Acts, xix. 19.*); whence came the proverb

proverb "Ephesian letters," signifying all sorts of spells or charms. By these Ephesian letters were meant certain obscure words and incoherent sentences, which superstitious bigots used to write on their girdles, and even imprint on their feet, and other parts of their bodies. They were also noted for their luxury and lasciviousness. See Ephes. v. 5.

Ephesus, in its relation to ecclesiastical history, may be considered, first of all, as the abode of many Jews, who obtained the privilege of citizens (Joseph. Cont. Appian. l. 2.), and afterwards, as the place where St. Paul took up his residence for three years (Acts, xx. 31.), where he wrought miracles (Acts, xix. 11. 1 Cor. xvi. 9.), and was resisted by the Jews, (Acts, xx. 19.); and where Timothy was bishop; and where John resided; and, moreover, as containing one of the seven churches, whose character and doom are recorded in the book of Revelations, ch. ii.

EPHESUS, *Temple of*. See DIANA.

EPHETÆ, of ἐφημι, *I send forth*, in *Antiquity*, a sort of magistrates among the Athenians, instituted by king Demophoon, to take cognizance of murder, manslaughter, and chance-medley.

Their number was one hundred, whereof fifty were Athenians, and fifty Argians: they were not admitted to the post till upwards of fifty years of age. Demophoon submitted to be tried by this court, for having unfortunately killed one of his subjects by the turn of his horse, as he was coming from Troy. It subsisted for a considerable time in the same form; but at length Draco new-modelled it, excluded the Argians, and made it to consist of fifty-one Athenians, each above fifty years of age: Ubbo Emmius de Rep. Athen. says, he transferred to them part of the jurisdiction of the Areopagites. See AREOPAGUS.

The occasion of erecting this court and of admitting the Argives to sit as judges, is said to have been as follows. Agamemnon, or, as others say, Diomedes, returning with his forces from Troy, were driven one night into an Athenian port called Phalerus, and thinking themselves in an enemy's country, began their usual practice of ravaging and plundering; upon which the Athenians fell upon and killed a considerable number of them. Next morning they found the palladium, or statue of Minerva, which was brought from Troy, lying upon the ground among the slain; by which circumstance they knew that they were their friends the Argives. The oracle having been consulted, ordered them to give the slain an honourable burial in the place where they fell, to build a temple there, dedicated to Minerva, and to set up the palladium in it. Immediately after this transaction, it was ordered that this court should be erected to try all cases of personal injury and property. It consisted of 50 members, who were to be above 50 years of age, men of sense and known probity, and who had power of life and death. Upon its first institution Agamemnon insinuating that there should be an equal number of Athenians and Argives, the Athenians readily agreed to the proposal.

EPHIALTES, ἐφιάλτης, in *Medicine*, from ἐπι, upon, and αλλομαι, *I leap*, is synonymous with the Latin *incubus*, and the English *night-mare*, which see.

EPHIALTEUM, in *Ancient Geography*, the most northern promontory of the isle of Rhodes.

EPHIDROSIS, in *Medicine*, from ἴπρι, and ἰδρῶς, *sweat*, a term used by the ancient writers to denote the appearance of a sweat, whether critical or not, and whether general, or on the upper parts of the body only. The modern nosologists have constituted a *genus* of disease under this appellation; under which Sauvages comprises every variety of morbid perspiration that occurs as a symptom of

different maladies. He enumerates seventeen species of ephidrosis. See his Nosol. Method, Class IX. Gen. 20. Cullen, Gen. 118.

EPHIELIS, in *Botany*, from ἐφιάλις, a little cup, or something like it, in a crown or garland, which alludes, happily enough, to the nectary forming a sort of cup, or crown, within the circle of the corolla. Schreb. 253. Willd. Sp. Pl. v. 2. 328. (Mataiba; Aubl. Guian. v. 1. t. 128. Juss. 249.) Class and order, *Oelandria Monogynia*. Nat. Ord. Near the *Sapindi*, Juss.

Gen. Ch. *Cal.* Perianth of one leaf, in five deep, spreading, roundish, acute segments. *Cor.* Petals five, roundish, spreading, notched, with a small point, and having claws as long as the calyx. Nectary of ten roundish hairy scales, smaller than the petals, two of them affixed to the base of each petal. *Stam.* Filaments eight, bristle-shaped, longer than the corolla, inserted into a gland; anthers roundish, with four angles. *Pist.* Germen ovate, encompassed with the gland which bears the stamens; style none; stigma obtuse. *Peric.* Capsule oblong, compressed, with a furrow on each side, of one cell and two valves. *Seeds* two, kidney-shaped, one attached to the middle of each valve, one above the other.

Eff. Ch. Calyx in five deep segments. Petals five, with claws. Nectary of ten scales, two to each petal. Capsule compressed, of one cell and two valves. Seeds two, attached to the valves.

The only known species is *E. fraxinea*, Willd. a tree 50 or 60 feet high, with copious branches, of which the central ones are erect, the rest widely spreading. Leaves alternate, pinnate, smooth; leaflets four or six, opposite, oval, pointed, entire, bright green, sometimes eight inches long. Flowers on long axillary branching stalks, very small, white. It grows in the forests of Guiana, flowering in October. Jussieu suspects this genus may be more akin to the *Leguminosæ* than to his *Sapindi*, but he observes that the fruit requires further investigation.

EPHIPPIA, of ἐπι and ἵππος, *horse*, denoted certain cloths or housings, which were fastened on a horse by a girth or surcingle, in ancient Greece, before the use of saddles were known. They were composed of different materials, as leather, cloth, and the skins of wild beasts, and sometimes adorned with gold, silver, and precious stones. When these coverings were common, it was reckoned more manly to ride without them. Varro boasts of having rode, when a young man, without a covering to his horse; and Xenophon reproaches the Persians because they placed more clothes on the backs of their horses than on their beds, and gave themselves more trouble to sit easily than to ride skilfully. These coverings were, therefore, for a long time not used in war; and the old Germans, who considered them as disgraceful, despised the Roman cavalry who employed them. (Cæs. de Bell. Gall. l. iv. 2.) Dion Cassius (l. lxxiii. 14.) says, that they were first allowed to the Roman cavalry by Nero. But it has been suggested that this author alludes merely to reviews, at which the cavalry were probably obliged before this time to appear always without them. In the time of Alexander Severus, the horses of the whole Roman cavalry had beautiful coverings. (Lamprid. Vit. Alex. Severi. c. 50.) Saddles were first denominated ephippia, which originally signified nothing more than a covering for a horse. Beckmann Hist. Inv. vol. ii. Berenger's Art of Horsemanship, vol. i. p. 41. See SADDLE.

EPHIPPIITES. See HIPPIURITES.

EPHIPPIUM, in *Anatomy*, the excavation in the upper surface of the sphenoid bone, called also sella turcica. See CRANIUM.

EPHOD, אֶפְדֹּד, derived from אָפַד, *aphád*, to clothe, a sacerdotal garment, in use among the ancient Jews, supposed to have been a kind of linen alb, or surplice, wore by persons of distinction, of various characters; the same with what the Latins call super-humerales. 2 Sam. vi. 4. 1 Sam. xxii. 18. 1 Sam. ii. 18.

It is very hard to say precisely what the ephod was; and there is room enough for the interpreters to be divided about it. The only point they are agreed upon is, that it was an upper garment worn over all the rest, immediately under the pectoral or breast-plate. Some hold it had sleeves, others deny it. The generality agree, that it was very short, though some maintain that it hung down to the feet behind.

There were two kinds of ephods; the one, common to all who assisted in the temple, being only made of common linen, mentioned in the first book of Samuel, ii. 18; the other, peculiar to the high-priest, mentioned Exod. xxviii. 6. 15. to be made of gold, of blue, and of purple, of scarlet, and fine twined linen, with cunning work; having two shoulder-pieces, with a curious girdle of the same matter, and two onyxes, with the names of the children of Israel engraved thereon, six upon each stone. These onyxes were set in gold, and served as buttons upon each shoulder. As for the shape of the ephod, the LXX call it *επιμυς*, which signifies that it was worn on the shoulders.

Josephus says (Antiq. l. iii. § 5), that it was a cubit long. It consisted, as some suppose, of two parts, the one an oblong rectangular piece, hanging down behind from the shoulders to the feet; the other a short rectangular piece, which hung down before, the length of a cubit. These two pieces were joined together upon the shoulders, with some proper fastening, as loops, buttons, or the like.

It is also expressed in the second book of Samuel, vi. 14. that upon the removal of the ark of the covenant from the house of Obed-Edom, David danced for joy, girt with a linen ephod; whence some authors have concluded, that the ephod was also a regal garment, worn on solemn occasions. It is probable that the peculiarity of the ephod of the high priest did not consist in its being of a different shape from that which was worn by other persons; but in the richness of the materials of which it was made, and the fine embroidery and jewels with which it was adorned.

EPHORI, Εφοροι, magistrates established in ancient Sparta, to balance and check the power and authority of the kings; as at Rome, there were tribunes created to controul the power of the consuls.

The word is formed of the Greek, *εφορα*, *intueor*, formed of the preposition *επι*, and the verb *οραω*, to see; whence *εφορος*, *q. d. inspector, overseer*.

Lycurgus, being sensible that a perfect understanding between the prince and the people was the basis and foundation of both their happiness, to maintain that good understanding, established ephori, or inspectors, as a kind of mediators, who should have an eye to the measures and conduct on both sides, and preserve so equal a balance between them, that the regal power should never decline into severity and tyranny, or the liberty of the people run into licentiousness and rebellion.

This is the account of their institution given by Herodotus and Xenophon. (Her. lib. i. Xen. de Rep. Lacedæm.) The authority of the ephori was very great; they presided in popular assemblies, collected their suffrages, declared war, made peace, treated with foreign princes, determined the number of forces that should be raised, appointed the funds to maintain them, and distributed rewards and punishments in the name of the state; they likewise held a court of jus-

tice, enquired into the behaviour of all magistrates, inspected the education and conduct of youth, had a particular jurisdiction over the helotes, and by degrees drew the whole administration into their own hands. On certain occasions, they expelled, and even put to death the kings; and abolished or suspended the power of the other magistrates, calling them to account at pleasure. Agesilaus, in the height of all his conquests, which even struck terror on the great king of Persia, stopped, and turned back, out of deference to the ephori, when they recalled him.

Some authors deny that the ephori were established by Lycurgus, dating their origin 130 years after the time of that legislator.

Thus Plutarch, in his life of Cleomenes, ascribes their institution to Theopompus, king of Sparta, which is also confirmed by the authority of Aristotle. (Polit. lib. v.) The ephori were five in number, and annually chosen by the people out of their own body: though some have imagined, that they were at first appointed by the kings at their pleasure, but that afterwards the people obtained the power of electing them. The year was denominated from the first election of these magistrates; and the Lacedæmonian armies took their names from the principal ephori, as those of Athens did from their first archon. The ephori did not rise up at the entrance of the kings, as all the other magistrates did; and if even the kings offended against the laws, the ephori took cognizance of their conduct, and punished them.

EPHORUS, in *Biography*, a Greek orator and historian, was a native of Cuma or Cyme in Æolia, and flourished about the year 352 B. C. He was a disciple of Socrates, at whose instigation he wrote history; which he commenced after the fabulous periods, with the return of the Heraclidæ into Peloponnesus, and brought down to the 20th year of Philip of Macedon. This work, which was divided into 30 books, was held in estimation by the ancients, and is frequently cited by Strabo and other writers; though the historian is charged with errors and misrepresentations, and plagiarisms. Besides the history, the loss of which is regretted, Ephorus wrote several other books on moral, geographical, and rhetorical subjects, none of which are extant, Bayle. Voss. Hist. Græc. Gen. Biog.

EPHRA, in *Ancient Geography*, a city of Judea, in the half-tribe of Manasseh, on this side of Jordan. It was situated on the frontiers of the tribe of Ephraim; supposed to have been the same with Ophrah. Judg. vi. 11.

EPHRAIM, *Tribe of*, so denominated from Ephraim, the grandson of Joseph by Aseneth, the daughter of Potiphar, who was born in Egypt about A. M. 2294, occupied the south side of Samaria, and extended, like that of Manasseh, from the Mediterranean on the west, and the river Jordan on the east; bounded on the south by the territory of Benjamin and part of Dan, and on the north by the half-tribe of Manasseh. The extent of this tribe from north to south was about 7 leagues; and though some parts were mountainous and rocky, they were covered with trees and good pasture, and the low lands were rich and fertile, and even luxuriant. The cities and towns were numerous, large, and well-peopled. Joshua was of this tribe; and the ark and tabernacle remained in it at Shiloh for a considerable time. After the separation of the 10 tribes, the seat of the kingdom of Israel being in Ephraim, Ephraim is frequently used to signify the whole kingdom. The district belonging to this tribe is called Ephratah. Ps. cxxxii. 6. (See also Judg. xii. 5. 1 Sam. i. 1.) Ephraim was led captive beyond the Euphrates, with all Israel, by Salmaneser, king of Assyria, A. M. 3283. B. C. 721.

EPHRAIM, or *Ephraim*, a city of Ephraim, towards Jordan, whither Jesus is supposed to have retired before his passion. John, xi. 54.—Also, a city of Benjamin, 8 miles from Jerusalem, according to Eusebius, near the wilderness of Judea, in the way from Jerusalem to Jericho, not far from Bethel.—Also, a considerable mountain in the tribe of Ephraim, and extending to that of Benjamin, on which several towns were built.—Also, an extensive forest situated on the other side of Jordan, not far from Mahanaim, where David abode while the battle was fought, in which Abalom received the due reward of his unnatural rebellion.

EPHRATA, or *DUNKARD-Town*, in *Geography*, a village of America, in Lancaster county, Pennsylvania, on the N.W. side of Calico creek, which, joining the Conestoga, falls into the Susquehanna; 12 miles N. of the town of Lancaster, and more than 40 W. of Philadelphia. It is situated in a romantic and sequestered vale, and inhabited by a community of religious people, called "Tunkers," who are mostly of German descent and believers in the doctrine of general redemption. They are very plain in their dress and language; and will neither swear, nor fight, nor go to law, nor take interest for the money they lend. They have many peculiarities; but their inoffensive manners have occasioned their being called the harmless Tunkers. This settlement is called "Tunkers' town," and consists of about 40 buildings, of which three are places of worship. They subsist by cultivating their lands, by attending a printing office, a grist-mill, a paper-mill, an oil-mill, &c. and the sisters by spinning, weaving, sewing, &c. Beside this congregation at Ephrata, there were, about 30 years ago, some few others of this sect in various parts of Pennsylvania, and in Maryland. The whole community, exclusively of those in Maryland, comprehended upwards of 2000 persons.

EPHRATAH. See *Tribe of EPHRAIM* and *BETHLEHEM*.

EPHREM, or *EPHRAIM*, denominated the *Syrian*, and honoured with the appellation of *Saint*, in *Biography*, was a native of Nisibis in Mesopotamia, and born during the reign of Constantine the Great. Devoting himself at an early period to the monastic life, he sedulously applied to his studies, and to the composition of various theological and moral works. Towards the close of his life he resided at Edessa, where he began to distinguish himself by his writings about the year 370, and was ordained deacon, determining not to accept of any higher ecclesiastical order. His works were all written in the Syriac language, and several of them were translated into Greek, with which he does not seem to have been acquainted, during his life. He was held in high estimation, on account both of his virtues and his writings. From Dr. Assemann we learn, that the Syrians gave him the titles of Doctor or Master of the whole world, and of their Prophet; and St. Jerome informs us, that his works were so much esteemed as to be publicly read in some churches after the Scriptures. Sozomen highly commends them both for style and sublimity of sentiment; which excellencies are said by this father, and also St. Jerome, to have been transfused into the Greek version of them. The subjects of these works were commentaries upon the Old and New Testaments; homilies, or sermons; exhortations to the monks; controversial pieces against Sabellius, Arius, Apollinaris, the Anomians, and the Novatians; treatises of morality; hymns to be sung in the churches; panegyrics, &c. of which we have an account by Cave, Du Pin, and Lardner. The most complete edition of the works of this writer was published at Rome, by Dr. Jos. Assemann, assisted by father Benedatti, a Jesuit, and Eyodius

Assemann, bishop of Apamea; which was begun in 1732, and finished in 1747, in 6 vols. folio, of which three are Syriac and Latin, and the other three Greek and Latin. St. Ephrem died about the year 378, under the reign of the emperor Valens; ordering his funeral to be conducted in a plain manner, and forbidding any eulogium to be delivered on the occasion, or any monument to be erected to his memory. With the acknowledged and applauded learning of Ephrem, a considerable degree of enthusiasm and fanaticism was blended; but his charitable disposition, which he manifested on a variety of occasions, endeared his name to survivors, and entitles him to honourable remembrance. Cave. Du Pin. Lardner. Jortin. Gen. Biog.

EPHREMI CODEX, in *Biblical History*, a manuscript of the New Testament, written on vellum, and supposed to be of very high antiquity. It is "Codex Regius 1905," noted in the catalogue of MSS. in the royal library in Paris IX., and in all the four parts of Wetstein's Greek Testament by the letter C. It is particularly described by Griesbach in his "Symbolæ," p. iii.—liv. The first part of it contains several Greek works of Ephrem the Syrian, written over some more ancient writings, which had been erased, though the traces are still visible, and in most places legible. These more ancient writings were the whole Greek Bible. The New Testament has many chasms, which are specified by Wetstein. Besides these chasms, it is in many places illegible. Wetstein contends that this MS. was written before the year 542, though his arguments are not wholly decisive. Its readings, like those of all other very ancient MSS., are in favour of the Latin; but no proof can be given that this has been corrupted from the Latin version. It has been altered by a critical collector, who, according to Griesbach, must have lived many years after the time in which the MS. was written, and has probably erased many of the ancient readings. Kuster was the first who procured extracts from it, and he inserted them in his edition of Mill's Greek Testament. Wetstein has repeatedly collated it with very great accuracy; and the numerous readings, which he has quoted from it, greatly enhance the value of his edition. A fac-simile of the characters of this MS., which is written without accents, is given by Montfaucou in his "Palæographia Græca." It has many marginal notes, written in uncial letters without accents. In this MS. the disputed, or rather spurious verse, John, v. 4, is written, not in the text, but as a marginal scholion. Wetstein supposed, that this was one of the MSS. which were collated at Alexandria in 616 with the new Syriac version; but though this does not appear to have been the case, it is certainly as ancient as the seventh century. Wetstein argues, from a marginal note to Heb. viii. 7, that it was written before the institution of the feast of the purification of the virgin Mary, that is, before the year 542. March's Michaelis, vols. ii. and iii.

EPHREMOS, or *YEPHREMOS*, in *Geography*, a town and district of Russia, in the government of Tula, situated on the river Metcha, falling into the Don.

EPHRON, in *Ancient Geography*, a place of Palestine, in the tribe of Judah, about 15 miles from Jerusalem, according to Eusebius and Jerome.—Also, a mountain of Palestine, on the confines of the tribes of Judah and Benjamin, according to the book of Joshua.—Also, a large and strong town of Judea, in the half-tribe of Manasseh, on the other side of Jordan, over-against Scythopolis. It was situated near the torrent of Jabok. This town was taken and sacked by Judas Maccabæus, and razed to its foundations.

EPHYDOR, *Εφυδωρ*, in *Antiquity*, an officer in the Athenian courts of justice, who was to provide the plaintiff and

and defendant with equal water hour-glasses. When the glass was run out, they were not permitted to speak any farther; and therefore we find them very careful not to lose or mispend one drop of their water. Whilst the laws quoted by them were reciting, or if any other business happened to intervene, they gave order that the glass should be stopped. Pott. Archæol. Græc. lib. i. cap. 21. lib. i. p. 118.

**EPHYRA**, in *Ancient Geography*, a town of Greece, in Thesprotia, a province of Epirus; mentioned by Velleius Paterculus and Strabo; the latter of whom says, that it was afterwards called *Cichyrus*.—Also, a town of Greece, in the Pelasgiotide, a country of Thessaly. This town was also called *Cranon*. Steph. Byz.—Also, a town of the Peloponnesus, in Arcadia. Steph. Byz.—Also, a town of the Peloponnesus, in the territory of Elis, situated on the river Selleis. This place was famous for the deadly poisons which it produced.

**EPI**, *Gr.* in *Music*, a preposition, which, like *hyper*, signifies *supra*, above. We find one of these words frequently added to the Greek names of some of the intervals of music; as

Epi, or hyper, { Diapason,  
Diapente,  
Diateffaron,  
Ditonum, &c.

When we meet with them thus in conjunction, they imply that the voice, in canons, is to follow the dux, or guide an octave, a fifth, a fourth, &c. below it. The third part is to observe the same rule with respect to the second, and the fourth to the third, and so on, whatever the number of parts may be.

**EPIACUM**, in *Ancient Geography*, a town of Albion, in the country of the Brigantes, according to Ptolemy. Camden places it at Elcheſter, on the river Derwent; Horsley at Hexham, in Northumberland; and Baxter supposes it was originally written Peliacum, and places it at Papcastle, in Cumberland.

**EPIALOS**, from *ἥσως*, gentle, and *ἄλς*, sea, in the *Medical Writings of the Ancients*, the name of a fever, in which the patient labours under a preternatural internal heat, while he at the same time shivers with cold. It has by some been called the shivering-fever, and the Romans named it *quercera*. Galen says, it proceeds from a putrid acid phlegm. The word is, by some, also applied to any gentle fever, or feverish complaint; and by others, to the cold or shivering fit preceding a fever. Hippocrates calls by this name that peculiar fever which attends young women, whose menses are stopped by taking cold, or other accidents.

**EPIAULIA**, a name which the Greeks gave to the Miller's Song. It is constantly confirmed, in inquiries after Greek music, that every profession, trade, and occupation, had its peculiar *nome*, tune, or song. Rousseau, so often satirical and sarcastic, but who seldom aims at pleasantry, has condescended to be joocular upon the Greek name for the miller's tune, by asking whether the burlesque word *piauler*, (whimpering, whining,) was not derived from the Greek; as the whimpering, whining, and squawling of women and brats, who cry and complain a long time in the same tone, sufficiently resemble the song or noise of a mill, and, by a metaphor, the miller?

**EPIBATÆ**, *Ἐπιβάται*, among the Greeks, marines or soldiers who served on board the ships of war. They were armed in the same manner as the land-forces, only that more of them wore full or heavy armour. Pott. Archæol. Græc. tom. ii. p. 140.

**EPIBATERION**, a poetical composition, in use among

the ancient Greeks. When any person of condition and quality returned home after a long absence or journey, into another country, he called together his friends and fellow-citizens, and made them a speech, or rehearsed them a copy of verses, wherein he returned solemn thanks to the immortal gods for his happy return; and ended with an address by way of compliment to his fellow-citizens.

These verses made what the Greeks call *ἐπιβάτηριον*, *epibaterium*, of *ἐπιβαίνω*, *I go abroad*. At going away they had another, called *ἀποβάτηριον*.

**EPIBATERIUM**, in *Botany*, from the Greek adjective *ἐπιβάτης*, climbing. Forst. Gen. 54. Schreb. 640. Willd. Sp. Pl. v. 4. 397. Juss. 285. Class and order, *Monocia Hexandria*. Nat. Ord. *Menispermæ*, Juss.

Gen. Ch. Male, *Cal.* Perianth double, deciduous; outer minute, flat, of six leaves; inner thrice as large, of three ovate spreading leaves. *Cor.* Petals six, smaller than the inner calyx, roundish; three of them external, placed between the calyx-leaves; three internal. *Stam.* Filaments six, capillary, incurved, the length of the petals; anthers roundish. Female, (on the same plant,) *Cal.* and *Cor.* as in the male. *Pist.* Germens three, superior, nearly globose; styles three, minute, incurved; stigmas spreading, compressed. *Peric.* Drupas three, roundish, pointed with the permanent styles. *Nut* kidney-shaped, compressed, slightly furrowed.

Ess. Ch. Male, Calyx double; the outermost of six, the inner of three leaves. Petals six, in two series. Stamens six. Female, Calyx and Corolla as in the male. Styles three. Drupas three, globular, pointed. Nuts solitary, kidney-shaped.

*E. pendulum* is the only species described, a native of the island of St. Jago. The stem is shrubby, climbing, with long pendulous branches. Leaves alternate, pointing one way, on short foot-stalks, oblong, entire, obtuse with a point, smooth and without ribs, about an inch long. Flowers minute, pale, on solitary, axillary, simple stalks.

**EPIBOMEUM**, the name of a cantic in the Greek music, which was sung before the altar.

**EPIC POEM**, an heroic poem, or a poem reciting some great and signal transactions of a hero; called also *ἑποποιία*. This kind of poem is universally allowed to be, of all poetical productions, the most dignified, and, at the same time, the most difficult in execution. To contrive a story which shall please and interest all readers, by being at once entertaining, important, and instructive; to fill it with suitable incidents; to enliven it with a variety of characters, and of descriptions; and to maintain, in the course of a long work, that propriety of sentiment, and that elevation of style, which the epic character requires, is unquestionably the highest effort of poetical genius. Hence it is that so few have succeeded in the attempt, and that strict critics will hardly allow any other poem to bear the name of epic, except the *Iliad* and the *Æneid*.

An epic poem, according to Bossu, is a discourse invented with art, to form the manners, by instructions disguised under the allegory of an important action related in verse, in a probable, entertaining, and surprising manner.

This definition, it has been observed, would suit *Æsop's fables*, if they were extended, and put into verse. Accordingly the critic draws a parallel between the construction of one of *Æsop's fables* and the plan of Homer's *Iliad*. The first thing, he says, which a writer of fables, or of heroic poems, does, is to choose some maxim or point of morality, designed to be inculcated in the work. He next invents a general story, or a series of facts, without any names, such as he conceives most proper for the illustration

of his intended moral. Lastly, he particularizes his story; that is, if he be a fabulist, he introduces his dog, his sheep, and his wolf; and if he be an epic poet, he draws from ancient history some proper names of heroes to be applied to his actors; and thus his plan is completed. This, says Dr. Blair, is one of the most frigid and absurd ideas that ever entered into the mind of a critic; nor can any person of just reflection and taste ever imagine, that Homer could have proceeded in this manner. No one, indeed, can entertain a doubt that the first objects which strike an epic poet are, the hero whom he is to celebrate, and the action, or story, which is to be the ground-work of his poem. "He does not sit down, like a philosopher, to form the plan of a treatise of morality. His genius is fired by some great enterprise, which to him appears noble and interesting; and which, therefore, he pitches upon as worthy of being celebrated in the highest strain of poetry. There is no subject of this kind, but will always afford some general moral instruction, arising from it naturally. The instruction, which Bossu points out, is certainly suggested by the Iliad; and there is another which arises as naturally, and may just as well be assigned for the moral of that poem; namely, that Providence avenges those who have suffered injustice; but that when they allow their resentment to carry them too far, it brings misfortunes on themselves. The subject of the poem is the wrath of Achilles, caused by the injustice of Agamemnon. Jupiter avenges Achilles, by giving success to the Trojans against Agamemnon; but by continuing obstinate in his resentment, Achilles loses his beloved friend Patroclus."

An epic poem is in its nature the recital of some illustrious enterprise in a poetical form. This definition is sufficiently exact; and hence it appears to comprehend several other poems besides the Iliad of Homer, the Æneid of Virgil, and the Jerusalem of Tasso; which are, perhaps, the three most regular and complete epic works that were ever composed. But to exclude all poems from the epic class, which are not formed exactly upon the same model as these, is, says Dr. Blair, the pedantry of criticism. This writer, therefore, does not scruple to class such poems, as Milton's Paradise Lost, Lucan's Pharsalia, Statius's Thebaid, Ossian's Fingal and Temora, Camoens's Lusiad, Voltaire's Henriade, Cambray's Telemachus, Glover's Leonidas, Wilkie's Epigoniad, under the same species of composition with the Iliad and Æneid. They are all, undoubtedly, epic; that is, poetical recitals of great adventures, and consequently belonging to this denomination of poetry.

The epic poem is distinguished from comedy, in that the action of the latter is not important, nor is related by the poet, but acted by the persons introduced for that purpose; which circumstance, likewise, distinguishes it from tragedy. It differs also from tragedy in the event, or conclusion; which, in the latter, is generally unfortunate, but seldom or ever so in the former. See ACTION.

Nor is it a philosophical poem, as that of Lucretius, or the Creation of sir R. Blackmore; nor a treatise of agriculture, or the like, as the Georgics of Virgil; those poems not being intended to form the manners; beside, that the instructions they contain are naked, simple, and direct, without any disguise or allegory. Which second circumstance likewise distinguishes it from a treatise of morality, written in verse; or a simple history in verse: add, that its being confined to one important action, distinguishes it from a poem which relates all the actions of a person's life.

M. de la Motte, indeed, in his controversy with madam Dacier, on the subject of Homer, maintains, that the

whole life of a hero may justly be made the subject of an epic poem: and even that the Lutrin of M. Boileau might pass for an epic poem; but he seemed afterwards to return to the common sentiment. In effect, the question is not as to the sense which may be annexed to the words epic poem, but the sense which custom has actually annexed to them.

If we had only regard to the etymology of the word epic, of *ἔπος, verse, poetry*, from *ἔπος, dico, I speak (relate)*, and poems wherein the poet speaks or rehearses things himself, without making the persons of his poems speak, except at second-hand, as he relates what they spoke on this or that occasion, would be properly epic poems; and so there is not an epigram, sonnet, or madrigal, but would come under that denomination: but this were wild.

In effect, the term epic poem is only attributed to a composition whose subject is great, instructive, and serious; that only comprehends one single principal event, to which all the rest refer; which principal action is to be terminated in a certain space of time, ordinarily about a year. It is true, all this is arbitrary; but the sense of all words is so too; and in matters of language we must be guided by custom.

If M. de la Motte had only pretended, that one might make a fine instructive poem on the whole life of a hero, or an agreeable and diverting poem on some humorous adventure, all the world would have been on his side. But it is enough that custom has not thought good to apply the term epic either to subjects of too much extent, and that are crowded with too many incidents no-way connected together; or to burlesque poems, as the Batrachomyomachia of Homer, the Secchia Rapita of Tassoni, the Défaite de Dulot, the Lutrin of Boileau, the Hudibras of Butler; the Rape of the Lock of Mr. Pope, or the Dispensary of Dr. Garth.

Dr. Blair cannot allow with Bossu and others, that it is the essence of an epic poem to be wholly an allegory, or a fable contrived to illustrate some moral truth; nevertheless, he admits, that no poetry is of a more moral nature than this. The effect, however, in promoting virtue is not to be estimated by any one maxim or instruction, which results from the whole story, like the moral of one of Æsop's fables; but from the impression which the parts of the poem separately, as well as the whole taken together, make upon the mind of the reader; from the great examples which it sets before us, and the high sentiments with which it warms our hearts. Its proposed end is to extend our ideas of human perfection, and thus to excite admiration; an end, which can be accomplished only by proper representations of heroic deeds and virtuous characters. Epic poems must, according to this statement of their object, be favourable to virtue. Moreover, the general strain and spirit of epic composition sufficiently mark its distinction from the other kinds of poetry. In pastoral writing, the reigning ideas are innocence and tranquillity; compassion is the great object of tragedy; and ridicule the province of comedy. But the predominant character of the epic is admiration excited by heroic actions. It is sufficiently distinguished from history, both by its poetical form, and the liberty of fiction which it assumes. It is a more calm composition than tragedy. It admits, nay, requires the pathetic and the violent on particular occasions; but the pathetic is not its general character. It requires more than any other species of poetry, a grave, equal, and supported dignity. It takes in a greater compass of time and action than dramatic writing admits; and thereby allows a more full display of characters. Dramatic writing displays characters chiefly by means of sentiments

ments and passions; epic poetry chiefly by means of actions. The emotions which it excites are, therefore, not so violent, but they are more prolonged. These, says Dr. Blair, are the general characteristics of this species of composition.

The epic poem may be considered under three heads; first, with respect to the subject, or action; secondly, with respect to the actors, or characters; and lastly, with respect to the narration of the poet.

The action must possess the following properties; it must be one, and entire, great, and interesting. (See ACTION and EPISODE. See also *ÆNEID*, *ILIAD*, *PARADISE LOST*, &c.) The actors or personages introduced in an epic poem must be discriminated by appropriate and well-supported characters; which is denominated by Aristotle giving manners to the poem. See CHARACTER, in *Poetry*.

If we examine the characters of Milton, we shall find that he has introduced all the variety which his fable was capable of receiving. The whole species of mankind was restricted to two persons at the time to which the subject of his poem relates. We have, however, four distinct characters in these two persons. We see man and woman in the highest innocence and perfection, and in the most abject state of guilt and infirmity; the two last characters are, indeed, very common and obvious, but the two first are not only more magnificent, but more novel than any characters either in Virgil or Homer, or indeed in the whole circle of nature. Milton was so sensible that the subject of his poem afforded him but few characters, as to be led to introduce two actors of a fictitious nature, in the persons of "Sin" and "Death," by which means he has wrought into the body of his fable a very beautiful and well invented allegory. However, it has been thought, that persons of such a chimerical existence are not proper actors in an epic poem; because there is not that measure of probability annexed to them, which is requisite in writings of this kind.

There is one circumstance, relating to the principal actors of the *Iliad* and *Æneid*, that merits particular notice, because it gives a peculiar beauty to these two poems, and was, therefore, contrived with very great judgment. This is the choice for their heroes of persons nearly related to the people for whom they wrote. Achilles was a Greek, and Æneas the remote founder of Rome. Their countrymen were thus rendered particularly attentive to all the parts of their story, and sympathized with their heroes in all their adventures. Milton's poem is also admirable in this respect; since it is impossible for any of its readers, to whatever nation, country, or people he may belong, not to be related to the persons who are the principal actors in it; but what is still infinitely more to its advantage, the principal actors in this poem are not only our progenitors, but our representatives. We have an actual interest in every thing they do, and no less than our utmost happiness is concerned, and lies, as it were, at stake in their whole behaviour.

Besides human actors, there are personages of another kind, that usually occupy no small place in epic poetry; such are the gods, or supernatural beings. This constitutes what is called the machinery of the epic poem; and it is the most nice and difficult part of the subject. About the necessity and use of machinery in an epic composition, critics have been divided. The French critics consider it as essential to the constitution of an epic poem; and they allege that a poem, though it should possess every other requisite, has no pretension to be ranked in the epic class, unless the main action be carried on by the intervention of the gods. This decision seems to be principally, if not solely, founded on a superstitious reverence for the practice of Homer and Virgil. But, although these poets very properly embellished their

respective story by the traditionary tales and popular legends of their own country, according to which, all the great transactions of the heroic times were intermixed with the fables of their deities; does it hence follow, that in other countries, and in other ages, which do not possess a similar advantage of current superstition, and popular credulity, epic poetry must be confined to antiquated fictions, and fairy tales? Lucan has composed a very spirited poem, certainly of the epic kind, where neither gods nor supernatural beings are at all employed. The author of Leonidas has also succeeded in an attempt of the same kind; and, without doubt, wherever a poet gives us a regular heroic story, well connected in its parts, adorned with characters, and supported with proper dignity and elevation, though his agents be every one of them human, he has fulfilled the chief requisites of this kind of composition, and has a just title to be classed with epic writers. Dr. Blair, whilst he cannot admit that machinery is indispensibly necessary or essential to the epic plan, differs from those critics of considerable name, who are for wholly excluding it, as inconsistent with that probability and impression of reality, which, as they conceive, should prevail in this kind of writing. (See *Elem. of Criticism*, ch. 22.) In epic poetry, where admiration and lofty ideas are supposed to reign, the marvellous and supernatural find, if any where, their proper place. They both enable the poet to aggrandize his subject, by means of those august and solemn objects which religion introduces into it; and they allow him to enlarge and diversify his plan, by comprehending within it heaven, and earth, and hell, men and invisible beings, and the whole circle of the universe.

In the use, however, of this supernatural machinery, a poet should be prudent and temperate. The system of the marvellous, which he introduces, should have some foundation in the popular belief, so that events, which are most contrary to the common course of nature, may derive from it an air of probability; and he should guard against excess in the use of it. As to allegorical personages, fame, discord, love, and the like, they form, says Dr. Blair, the worst machinery of any; and though they may serve for embellishment, they should not be permitted to bear any share in the action of the poem.

With regard to the narration in an epic poem, it is not of any great moment, whether the poet relate the whole story in his own character, or introduce some of his personages to relate any part of the action that had passed before the poem opens. Homer follows one method in his *Iliad*, and the other in his *Odyssey*. Virgil has, in this respect, imitated the conduct of the *Odyssey*; Tasso that of the *Iliad*. Where the subject is of great extent, and comprehends the transactions of several years; as in the *Odyssey* and the *Æneid*, the latter method seems preferable. When the subject is of smaller compass, and shorter duration, as in the *Iliad* and the *Jerusalem*, the poet may, without disadvantage, relate the whole in his own person. It is of very considerable importance in the course of the narration, that it be perspicuous, animated, and enriched with all the beauties of poetry. No sort of composition requires more strength, dignity, and fire, than the epic poem. "It is the region," says Dr. Blair (*Lectures on Rhetoric*, &c. vol. iii.) "within which we look for every thing that is sublime in description, tender in sentiment, and bold and lively in expression;" and, therefore, though an author's plan should be faultless, and his story ever so well conducted, yet, if he be feeble, or flat in style, destitute of affecting scenes, and deficient in poetical colouring, he can have no success. The ornaments which epic poetry admits must  
all

all be of the grave and chaste kind. Nothing that is loose, ludicrous, or affected, finds any place there. All the objects which it presents ought to be either great, or tender, or pleasing. Descriptions of disgusting or shocking objects should as much as possible be avoided; and, therefore, the fable of the Harpies, in the third book of the *Æneid*, and the allegory of Sin and Death, in the second book of *Paradise Lost*, had been better omitted in these celebrated poems. Mr. Addison, in his critique on the *Paradise Lost* (*Spectator*, vol. iv.), has introduced several pertinent remarks on this subject. The sentiments, which in an epic poem are the thoughts and behaviour ascribed by the author to the persons whom he introduces, should be conformable to the respective characters of these persons, and when this is the case they are said to be *just*. The sentiments have likewise a relation to *things* as well as to *persons*, and they are then perfect, when they are adapted to the subject. If in either of these cases the poet endeavours to argue or explain, to magnify or diminish, to raise love or hatred, pity or terror, or any other passion, we ought to consider whether the sentiments he makes use of are proper to those ends. Homer is censured by the critics for his defect as to this particular in several parts of the *Iliad* and *Odyssey*; but candour ascribes this defect to the times in which he lived. Virgil has excelled all others in the propriety of his sentiments. Milton is likewise commended in this respect; and he claims peculiar praise from the consideration, that most of his characters lie out of nature, and were to be formed purely by his own invention. The loves of Dido and *Æneas* are merely copies of what has passed between other persons. Whereas Adam and Eve, before the fall, are a different species from that of mankind, who are descended from them; and no one but a poet of the most unbounded invention, and the most exquisite judgment, could have introduced into their conversation and behaviour so many apt circumstances during their state of innocence. An epic poem should abound not only with such thoughts as are natural, but also with such as are sublime. In this respect Virgil is inferior to Homer. Indeed, Virgil seldom rises into sentiments that are astonishing, where he is not fired by the *Iliad*. He every where charms and pleases us by the force of his own genius; but seldom elevates and transports us where he does not deduce his hints from Homer. Milton's chief talent, and distinguishing excellence, lie in the sublimity of his thoughts. In the greatness of his sentiments he triumphs over all the poets both ancient and modern, Homer only excepted. As sentiments that are natural and sublime are always to be pursued in an heroic poem, there are two kinds of thoughts, which should be carefully avoided; the first are such as are affected and unnatural, and the second such as are mean and vulgar. In Virgil we meet with little or nothing that resembles the first kind of thought: none of those trifling points and puerilities that often occur in Ovid, none of the epigrammatic turns of Lucan, none of the swelling sentiments that are so frequent in Statius and Claudian, and none of the mixed embellishments of Tasso. Every thing is just and natural. Milton has sometimes erred in this respect; and it is urged as his apology, that he was infected by the taste and practice of the age in which he lived. Mean and vulgar thoughts have rendered Homer obnoxious to censure; but his advocates have imputed sentiments of this kind to the age in which he wrote, and to that which he described, rather than to any imperfection in that divine poet. No blemish of this kind is observable in Virgil, and Milton is seldom chargeable with it.

We have already observed, that the language of an

heroic poem should be both perspicuous and sublime. In proportion as either of these two qualities are wanting, the language is imperfect. See farther of the nature of the epic poem under *FABLE*. For its matter, see *ACTION*. For its form, see *NARRATION*. For its versification, see *HEXAMETER*. See also *MANNERS*, *CHARACTERS*, *MACHINE*, &c. See also *ÆNEID*, *ILIAD*, *TASSO'S Jerusalem*, *CAMOENS'S Lusiad*, *FENELON'S Telemachus*, *VOLTAIRE'S HENRIADE*, and *MILTON'S PARADISE Lost*.

*EPICAIROS*, in *Ancient Geography*, a town of Palestine, E. of Jordan. Ptolemy.

*EPICARIA*, a town of Illyria, in Dalmatia. Ptol.

*EPICAUMA*, (from *επι*, and *καυω*, to burn). See *EXCAUMA*.

*EPICEDION*, *Επικεδιον*, formed of *επι*, upon, and *κεδος*, funeral, in the *Greek and Latin Poetry*, was a funeral eulogy, or a composition in prose or verse, delivered over the corpse of a friend or neighbour, commemorative of the virtues of the deceased. In celebrating the obsequies of distinguished persons three kinds of funeral discourses were used on the occasion. One, delivered when the friends were assembled to perform the last mournful offices for the dead, was termed *epicedium*; another, at the rogos, bustum, or funeral pile, *nenia*; and that inscribed on the tomb or cenotaph, *epitaphium*. In the early ages of society, the *epicedium* was generally an extemporaneous effusion of some near relative or affectionate friend, expressive of the sentiments he felt at the loss, and calculated to excite the common sympathy of the surrounding attendants. Beautiful specimens are given of this species of postobituary respect by Virgil in the *Æneid*: the one (lib. ix.) on the death of Euryalus, and the other (lib. xi.) on the death of Pallas. But in subsequent periods, when wealth and luxury had supplanted the simplicity of nature, and truth of feeling had been obliged by fashion to yield to the flattery of pomp; the custom, though preserved, materially differed in its character and form. What once had been the proper expression of undissimulated esteem, was changed into a degrading system of pagantry and venality. In most public funerals, but more especially in those called *vindictivi*, the corpse, previous to interment, was carried into the forum, attended by a vast train of invited or hired followers, when one of the relatives, or some orator of eminence, ascended the rostrum, and harangued the audience in praise of the departed friend or hero. The origin of this custom is attributed to Valerius Publicola, after the expulsion of the regal title. He having honoured the obsequies of his colleague with a funeral oration, so pleased the vanity of the Roman people, that it soon became fashionable to celebrate the funerals of great or distinguished characters with panegyrics, or encomiastic orations. The practice became at length so popular, that the younger Pliny, in his epistle, lib. ii. ep. 1. considers it as the last, but not the least addition to the happiness of a great and good man, to have had the enviable honour of being commended at his funeral by the eloquence of the consul, Tacitus. Nor was this privilege exclusively confined to men; for Livy relates that the Roman matrons, having been extremely liberal and active in raising a collection of gold to enable the government to deliver the city from the hands of the Gauls, were allowed, by an act of the senate, to have the privilege of *epicedia* being pronounced at the celebration of their obsequies, equally with the other sex. The abuses to which this custom was liable, and to which it actually became in time subservient, are made the subjects of just complaint, and pointed animadversion, both by Cicero and Livy; as tending, by the fulsome flattery, to weaken the motives to virtue, and by the greater attention which

those posthumous orators paid to the blandishments of eloquence, than to the accurate statement of facts, to falsify the page, and corrupt the source of history. For on such occasions the orator did not fail to extol the deceased in the most unqualified terms of praise, to emblazon his virtues in the most brilliant colours, and to place to his credit noble actions which he had never achieved. Particularly when the orator entered on an investigation of the lineage of the party, he seldom failed to ally him to some patrician family, or dignify his pedigree, by associating with his name some of the most renowned characters in the commonwealth to illustrate and confirm the descent, so that gradually, by means of these misrepresentations being recorded, the epicedia tended to obliterate the just distinctions of consanguinity, and throw down the barriers of property. From this heathen custom are derived obituary masses, orations funebres, and funeral sermons.

EPICERASTICS, *Επικεραστικά*, formed of *επι* and *κερασμα*, *I moderate*, in *Medicine*, remedies which, by their temperate moisture, soften the acrimony of a humour, and assuage the painful sensation of a part irritated or afflicted by it; such are the roots of althæa, mallows, liquorice; leaves of lettuce, mallows, water-lily, purslain; the seeds of flax, poppy, &c. See *EMOLLIENTS*.

EPICHRMUS, in *Biography*, a native of the island of Cos, who flourished in the 5th century, B. C. His father removed him at an early age to Megara, and afterwards to Syracuse, where he became a disciple in the Pythagorean school. Being prevented, by the tyranny of Hiero, from assuming the public profession of philosophy, he chiefly applied himself to the study of dramatic poetry, and offended the Pythagoreans, by introducing the doctrines and precepts of Pythagoras upon the stage. His comedies were numerous, of which Suidas assigns to him 52; but only some few fragments remain. He taught a school at Syracuse, and is said to have invented the two Greek letters *θ* and *χ*. He also wrote commentaries upon physical and medical subjects. We have no accurate account of his philosophical tenets: but some of his apophthegms deserve to be recorded; such are the following: "To die is an evil; but to be dead is no evil." "Every man's natural disposition is his good or evil dæmon." "He who is naturally inclined to good is noble, though his mother was an Ethiopian." "Be sober in thought, be slow in belief; these are the sinews of wisdom." "The gods set up their favours at a price, and industry is the purchaser." "Live so as to be prepared either for a long life or a short one." According to Lucian, the life of Epicharmus was prolonged to the age of 97 years. Laert. l. viii. § 78. Suidas. Fabr. Bib. Græc. v. i. p. 676. Brucker's Phil. by Enfield, vol. i.

EPICHIREMA, *Επιχίρημα*, in *Logic*, an argumentation, consisting of four or more propositions, some of which are proofs of others.

Thus, that oration of Cicero for Milo may be reduced to the epichirema: "Those who way-lay a man to kill him, it is lawful for him to kill, as is allowed by the laws of nature and nations, and by the practice of the best men; but Clodius way-laid Milo with that view, as appears from his forming an ambuscade before his country-house, and from his provision of weapons, soldiers, &c." Therefore it was lawful for Milo to kill Clodius.

EPICHIROTONIA, among the Athenians. It was ordained by Solon, that once every year the laws should be carefully revised and examined; and if any of them were found unsuitable to the present state of affairs, they should be repealed. This was called *επιχίροτονία των νόμων*, from the

manner of giving their suffrages, by *holding up their hands*. See a farther account of this custom in Pott. Archæol. Græc. lib. i. cap. 26. tom. i. p. 142.

EPICHOORDIS, from *χορδή*, an *intestine*, in *Anatomy*, a name given by some to the mesentery.

EPICHUS, or TACAPE (*Gabs*), in *Ancient Geography*, a town of Africa, on the coast of the Mediterranean sea, S. of Tephura. See *GABS*.

EPICITHARISMA, in the *Ancient Music*, an air for the cithara, said to be played at the end of dramatic pieces; which, consequently, must have been to Greek plays what a terminating ballet is now to an opera.

EPICLEROS, *Επικληρος*, among the Athenians, a daughter that had no brothers, and therefore inherited her father's whole estate. See *EPIDICASIA*.

EPICÆNE, *Επικαινοι*, in *Grammar*, a term applied to nouns, which, under the same gender and termination, mark, indifferently, two kinds of sexes. See *GENDER*.

Such in Latin, are *aquila*, *vespertilio*, &c. which signify equally a male or a female eagle, or bat.

Grammarians distinguish between epicæne and common. A noun is said to be common of two kinds, when it may be joined either with a masculine or a feminine article; and epicæne, when it is always joined to some one of the two articles, and yet signifies both genders.

EPICOLIC REGION, in *Anatomy*, from *επι*, upon, and *κόλιον*, the colon, that part of the abdomen which is above the colon.

EPICRANIUS, a thin and broad muscle, covering the superior arched portion of the cranium, and called also fronto-occipitalis, and occipito-frontien; or described as two muscles by the names of frontalis and occipitalis.

If we describe this as a single muscle, which we consider as the most natural and correct method, it will belong to the class of digastric muscles, or of such as possess a middle tendon, with fleshy fibres connected to its two ends. The aponeurosis is a very broad but thin plane, made up of tendinous fibres, variously interwoven, covering the upper part of the cranium, and hence called by Soemmerring *galea crani aponeurotica*. It is separated, along the middle, by a narrow interval from the opposite muscle, and it extends externally as far as the semicircular line, to which the temporal fascia is affixed. Its outer surface adheres closely to the scalp, while the inner is much more loosely connected, by a yielding cellular substance free from fat, to the pericranium. Its edges are insensibly continued into the neighbouring cellular substance.

The frontal portion is a thin flattened layer of muscular fibres, commencing by a femilunar edge from the front of the aponeurosis, and descending in a straight course to the eyebrow. Internally it is continuous with the opposite muscle, and detaches a portion of fibres along the side of the nose, to join the compressor narium, and levator labii superioris and alæ nasi. It then terminates by joining the orbicularis palpebrarum, through the whole of its upper convexity, and it is also connected with the corrugator supercilii. The external surface of this muscle is covered by the integuments of the forehead; and its inner surface lies on the frontal bone and os nasi.

The occipital portion is not so broad as the preceding. Arising from the back edge of the aponeurosis, it is inserted into the upper part of the external transverse ridge of the occipital bone. It covers the occipital and a little of the temporal bone, and is covered by the scalp.

It is very obvious that the occipito-frontalis cannot affect the bones of the head; but it moves the integuments in different directions; in consequence of the connection between  
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its tendon and the scalp. When the frontal and occipital portions act alternately, they draw the common tendon backwards and forwards, and thereby impart considerable motion to the whole hairy scalp. If they act together, they will render the aponeurosis tense. When the frontal acts separately, it draws up the eyebrow and skin of the forehead, and throws the latter into transverse wrinkles. Hence it is concerned in the expression of the countenance, and acts more especially in the gay and joyful emotions, directly antagonising the corrugator supercilii, which throws the forehead, and particularly the eyebrows, into longitudinal wrinkles. It contributes also, by means of its connection with the upper eyelids, to the opening of the eyelids, when we carry that to as great an extent as possible. The separate action of the occipital can only produce a slight effect on the integuments of the back of the head. Its contraction, however, fixes the aponeurosis, and renders it a firm point for the contraction of the frontal in raising the eyebrow and eyelid. This muscle, on the whole, is strongly analogous to the panniculus carnosus of quadrupeds.

EPICRASIS, in *Medicine*, is a gradual evacuation of ill humours in the blood.

EPICRISIS, *Ἐπικρίσις*, in *Rhetoric*, a clear and brief declaration of the speaker's judgment concerning the subject in hand. Thus, "ego sic statuo, in optimo imperatore quatuor has res inesse oportere, &c." Voss. *Rhet. lib. vi. p. 495*.

EPICTETI, in *Ancient Geography*, a people, who, according to Strabo, bounded Bithynia on the east. Hence the western part of Phrygia obtained the appellation of "Phrygia Epictetus." In this territory was the source of the river Hermus, and the town of Ancyra was situated in it, on the frontiers of Mysia.

EPICTETUS, in *Biography*, an eminent Stoic philosopher, no less distinguished for his virtues than his wisdom, was born in a servile condition at Hierapolis in Phrygia, and flourished in the first century of the Christian era. At an early age he was sold as a slave to Epaphroditus, a celebrated freedman of Nero, to whom Josephus inscribed most of his works, and who was afterwards put to death by Domitian. Epictetus was lame; and of this infirmity various causes have been assigned by different writers. Celsus relates, that when his master, in order to torture him, squeezed his leg very hard, the philosopher betrayed no symptoms of fear, but said very calmly to his tormentor; "You will break my leg;" and when it was broken, he only said with a smile, "Did I not tell you that you would break it." Some say, that he was born lame; and others ascribe his lameness to the heavy chains with which his master loaded him. Epictetus, having, by some means which are not recorded, obtained his freedom, retired to a small hut within the city of Rome, where, in an indigent condition, he devoted himself to the study of philosophy. Having in his retirement acquired a competent knowledge of the principles of the Stoic sect, and having also received instructions in rhetoric from Rufus; he became, notwithstanding his poverty, a popular preceptor of morals. He was an acute and judicious observer of manners; his eloquence was simple, majestic, nervous, and penetrating: his doctrine inculcated the purest morals; and his life was an admirable pattern of sobriety, magnanimity, and the most rigid virtue. His reprehensions of vice were bold and animated; his instructions and precepts impressive and conciliating; and they were communicated without that dogmatism, vanity, and rudeness, which were too generally affected by the philosophers. He was accustomed to observe, that the sum of

moral instruction may be comprised in two words, *ἀντὶς καὶ ἀπέχεσθαι*, i. e. endure and abstain, or bear and forbear. Aulus Gellius represents him as the greatest man the sect of the Stoics ever produced. The tyranny of Domitian, notwithstanding his extreme poverty and singular merit, included him in the number of those philosophers who were banished from Italy; and to the arbitrary decree of this monster, he calmly submitted, considering himself as a citizen of the world, and fully apprised, that wherever he went he carried his best treasure along with him. At Nicopolis in Epirus, which he chose as the place of his residence, he pursued his design of correcting vice and folly by the precepts of philosophy. The wisdom and eloquence of his discourses were held in such high estimation, that his hearers were very numerous, and it became a common practice among them to commit his instructions to writing. It is not certain whether he returned to Rome after the death of Domitian; but the respect which Adrian entertained for him renders it probable, that he spent the latter part of his life in that city. Here, however, he obtained no favours, that could induce him to abandon that humble condition of contented and independent poverty, which he had selected, and in which he determined to remain. Of the time and manner of his death we have no certain account. Themistius and Suidas assert that he lived till the time of the Antonines; but from the mention that is made of him by Aulus Gellius and Marcus Aurelius, it is probable that he died towards the close of the reign of Adrian. His name and memory were so much respected after his decease, that, according to Lucian, the earthen lamp, by which he used to study, was sold for 3000 drachmas, or more than 90% of our money. The testimony of Suidas, who asserts that Epictetus wrote many books, is not supported by any ancient author; however this be, the only remains of this philosopher are his beautiful moral manual, entitled "Enchiridion," and his "Dissertations," selected by Arrian, which were drawn up from notes taken by his disciples from his lips. Arrian's account of his life and death is not now extant. Simplicius has left a commentary upon his doctrine, in the eclectic manner. There are also various fragments of his wisdom preserved by Antoninus, Gellius, Stobæus, and others. Although the doctrine of Epictetus is less extravagant than that of any other Stoic, his writings every where breathe the true spirit of Stoicism. The tenet of the immortality of the soul was adopted and maintained by him with a degree of consistency suited to a more rational system than that of the Stoics, who inculcated a renovation of being in the circuit of events, according to the inevitable order of fate; and his exhortations to contentment and submission to Providence are enforced on much sounder principles than those of the Stoics. He also strenuously opposed the opinion held by the Stoics in general, concerning the lawfulness of suicide; and his whole system of practical virtues approaches nearer than that of any other instructor, unenlightened by revelation, to the purity of Christian morality. We have various editions of the remains of this philosopher, published at Leyden in 1670, in 8vo. cum notis variorum; at Utrecht in 1711, in 4to.; at Oxford, in 1740, in 8vo. by Joseph Simpson, together with the Table of Cebes, &c.; at London in 1742 by J. Upton, in two volumes 4to. which is the most valuable of all. The Enchiridion was published by C. G. Heyne, in 1776, in 8vo. and, together with Cebes's table, by Schweighauser, in 1798, 8vo. These have been translated into various languages; but the most esteemed version in our country is that by Mrs. Carter, published in 1758, with notes. Fabr. *Bib. Græc. v. iii. Aul. Gell. l. i. c. 2. Arrian, l. i. iii. Lucian in Pereg.*

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t. iv. Adv. Indoct. lib. cment. t. ii. Brucker's Hist. Phil. by Enfield, vol. ii.

EPICUREANS, a sort of ancient philosophers, who adhered to the doctrines and opinions of Epicurus. See EPICURUS.

The doctrines of Epicurus, as they are stated in a just, comprehensive, and elaborate detail by Brucker in his "History of Philosophy," translated and abridged by Dr. Enfield, are arranged under the distinct heads of Philosophy in general, canons or rules of philosophising, Physics, and Ethics. Philosophy is the exercise of reason in the pursuit and attainment of a happy life; whence it follows, that those studies which conduce neither to the acquisition nor the enjoyment of happiness are to be dismissed as of no value. The end of all speculation ought to be, to enable men to judge with certainty what is to be chosen, and what to be avoided, to preserve themselves free from pain, and to secure health of body and tranquillity of mind. Accordingly, the young should apply to the study of it without delay, nor should the old be ever weary in the pursuit of it. As nothing ought to be dearer to a philosopher than truth, he should prosecute it by the most direct means, devising no fictions himself, nor suffering himself to be imposed upon by the fictions of others, neither poets, orators, nor logicians; making no other use of the rules of rhetoric or grammar, than to enable him to speak or write with accuracy and perspicuity, and always preferring a plain and simple to an ornamented style. A wise man will embrace such tenets, and only such, as are built upon experience, or upon certain and indisputable axioms. Philosophy consists of two parts:—physics, which respect the contemplation of nature; and ethics, which are employed in the regulation of manners. Of these, the latter is the most important; the knowledge of nature being only necessary as a means of promoting the happiness of life. Philosophers have added a third part, dialectics; which ought to be rejected, as only productive of thorny disputes, idle quibbles, and fruitless cavilling. In order to facilitate the pursuit of knowledge, a few plain maxims and rules may be useful. Truth is of two kinds; that which respects real existence, and that which consists in a perfect agreement between the conception of the mind and the nature of things. In order to judge rightly concerning truth, it is necessary to use some criterion, or instrument, of judging. This criterion will vary according to the nature of the object which the mind contemplates. In judging of natural and moral objects, the three instruments employed are sense, preconception, and passion. The maxims, or canons, pertaining to sense, are four: First, that the senses can never be deceived, and consequently, that every perception of an image, or appearance, is true; that is, that the perception, or simple apprehension, and its efficient cause, the species or image flowing from the object, really agree. Secondly, opinion, or judgment, is consequent upon perception, and admits of truth or falsehood. Perceptions, or sensations, are the effect of real external *phenomena*; but when the mind judges concerning these appearances, the opinion may be either right or wrong. Thirdly, every opinion is to be admitted as true, which is attested, or not contradicted, by the evidence of the senses, after a careful and deliberate examination of every circumstance which can be supposed to affect the question. Fourthly, an opinion contradicted, or not attested by the evidence of the senses, is false. Thus, the opinion of a *Plenum* must be false, because it contradicts the evidence of the senses, which attest, that there is such a thing as motion. Concerning the second instrument of judgment, *viz.* *πρόληψις*,

or pre-conception, four canons may be laid down. First, that all pre-conceptions are derived from the senses, either by immediate impression, as of an individual man; by enlargement or diminution, as of a giant or dwarf; by resemblance, as of an unknown city to one which has been seen; or by composition, as of a centaur. Secondly, pre-conception is necessary to enable us to reason, inquire, or judge of any thing. Thirdly, pre-conceptions, or universal notions, are the principles of all reasoning and discourse; and we easily refer to these in comparing one thing with another. If these notions be agreeable to nature, and distinctly conceived, artificial reasoning will be unnecessary. Fourthly, truths, not self-evident, are to be deduced from manifest pre-conceptions; or, where the relation of ideas is obscure, it is to be made evident by the intermediate use of some acknowledged principle. The third instrument, passion, or affection, which comprehends pleasure and pain, admits of the following four evident maxims. First, all pleasure, to which no pain is annexed, is for its own sake to be pursued. Secondly, all pain, to which no pleasure is annexed, is for its own sake to be avoided. Thirdly, that pleasure, which either prevents the enjoyment of a greater pleasure, or produces a greater pain, is to be shunned. Fourthly, that pain, which either removes a greater pain, or procures a greater pleasure, is to be endured. As to the use of words, two canons are sufficient. First, in speaking, use terms in common use, and in the sense in which they are commonly understood. Secondly, in hearing, or reading, attend carefully to the signification which the speaker or writer affixes to his terms. Attention to these maxims would prevent much obscurity and confusion, and terminate many disputes. By these rules Epicurus undertook to conduct his followers into the secrets of nature, and to lay open to them the origin of things.

The physical doctrine of Epicurus was as follows: Nothing can ever spring from nothing, nor can any thing ever return to nothing. The universe always existed, and will always remain; for there is nothing into which it can be changed. There is nothing in nature, nor can any thing be conceived, besides body and space. Body is that which possesses the properties of bulk, figure, resistance, and gravity: it is this alone which can touch and be touched. Space, or *vacuum*, destitute of the properties of body, incapable of action or passion, is the region which is or may be occupied by body, and which affords it an opportunity of moving freely. The existence of bodies is attested by the senses. Space must also exist, in order to allow bodies place in which to move and exist; and of their existence and motion we have the certain proof of perception. Besides body and space, no third nature can be conceived. But the existence of qualities is not precluded, because these have no subsistence except in the body to which they belong. The universe, consisting of body and space, is infinite. Bodies are infinite in multitude; space is infinite in magnitude. The universe is immovable, because there is no place beyond it into which it can move. It is also eternal and immutable, since it is liable to neither increase nor decrease, to production nor decay. Nevertheless, the parts of the universe are in motion, and are subject to change. All bodies consist of parts, which are either themselves simple principles, or may be resolved into such. These first principles, or simple atoms, are divisible by no force, and therefore must be immutable. The existence of such atoms is indisputable, because it is impossible that any thing which exists should be reduced to nothing. A finite body cannot consist of parts infinite either in magnitude or number; and therefore divisibility of bodies *in infinitum* is inconceivable. All atoms are of the same

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nature, without any difference in essential qualities; and yet it appears, from their different effects upon the senses, that they differ in magnitude, figure, and weight. Atoms exist in every possible variety of figure; and yet on account of their solidity, they are infrangible, or incapable of actual division. Gravity is an essential principle of atoms; for being perpetually in motion, or making an effort to move, they must be moved by an internal impulse, which may be called gravity. By this internal force, atoms are carried forward in a direction, which is nearly rectilinear; and whilst they pass through free space, their declination from a right line occasions a casual concurrence of corpuscles of different forms. Thus various kinds of curvilinear motion will be produced. Moreover, when one atom is reflected from another, and again repelled by a third, it will acquire a kind of vibratory or tremulous motion. Hence an universal agitation will ensue. The principle of gravity, being essential to the primary corpuscles or atoms, these must have been incessantly, and from eternity, in actual motion; and with a velocity, when no obstacle intervenes, which will cause them to pass through the greatest imaginable space in the smallest imaginable portion of time. All atoms are also supposed, whilst they pass without resistance through the same empty space, to move with equal velocity; and though, by collision, their direction may be changed, their velocity is not diminished. Atoms are the elements from which all things are compounded, and into which they are resolved; and the energy, or principle of motion, which essentially belongs to them, is the sole agent in the operations of nature. Action originates in atoms, and from these proceeds to compound bodies. All the changes which take place in the figure, and other properties of bodies, consist in local motion. Bodies are more or less rare, in proportion to the size of the vacancies which intercept the solid atoms of which they are composed. Transparency depends partly upon the same cause, and partly upon the position of the vacancies between the particles: for rays of light will pass easily through a dense body, as glass, if its vacancies be placed in a straight line. Hardness and softness, flexibility, ductility, and other qualities, may be explained in a similar manner. The weight of a body is the result of the weight of all its atoms; and since gravity is an essential property of all atoms, all bodies must be heavy; and the only reason why some bodies appear to have the contrary principle of levity is, that they are driven upwards by the denser mass in which they are placed. Heat is the influx of certain small, round, soft corpuscles, which insinuate themselves into the pores of bodies in continual succession, till by their perpetual action, the parts are separated, and at length the body dissolved. The sense of heat is the perception of the separation of parts, which were before contiguous. Cold is the influx of certain irregular atoms, whose motion is slower than that of those which occasion heat, and their effect the reverse of the former. Pleasure and pain, motion and rest, and even time, are actions of bodies. Production and dissolution are nothing more than a change of the position of atoms, or an increase or diminution of the particles of which bodies are composed. The world is finite and terminable, and must have some figure, though this cannot possibly be ascertained. It is not eternal, but began at a certain time to exist; for since every thing in the world is liable to vicissitudes of production and decay, the world itself must partake of them. This may also be inferred from the short date of history, and the late invention of arts.

The formation of the world may be conceived to have happened in the following manner: a finite number of that

infinite multitude of atoms, which, with infinite space, constitutes the universe, falling fortuitously into the region of the world, were in consequence of their innate motion collected into one rude and indigested mass. In this chaos, the heaviest and largest atoms, or collections of atoms, first subsided, whilst the smaller, and those which from their form would move most freely, were driven upwards. These latter, after many reverberations, rose into the outer region of the world, and formed the heavens. Those atoms, which by their size and figure were suited to form fiery bodies, collected themselves into stars: those which were not capable of rising so high in the sphere of the world, being disturbed by the fiery particles, formed themselves into air. At length from those which subsided was produced the earth. By the action of air, agitated by heat from the heavenly bodies upon the mixed mass of the earth, its smoother and lighter particles were separated from the rest, and water was produced, which naturally flowed into the lowest places. In the first combination of atoms, which formed the chaos, various seeds arose, which, being preserved and nourished by moisture and heat, afterwards sprung forth in organized bodies of different kinds. Of the animal productions of the earth, some may be conceived to have been produced imperfect, and therefore incapable of life, but others would come forth more perfect. These, after the earth was exhausted of its seminal virtues, would respectively continue their species. The world, thus formed, would be preserved by the same mechanical causes which produced it; but by the incessant motion of atoms, which alone are solid and incorruptible, it would gradually tend to dissolution. In process of time nothing will remain but separate atoms and infinite space. As atoms are infinite, the number of worlds may also be infinite. The earth occupies the middle part of the world; but no point within it is properly the centre of gravity, for all heavy bodies fall in nearly parallel lines. The doctrine of Antipodes, according to the Epicurean philosophy, is false. The figure of the earth is a circular plane; and it is preserved from falling towards the lower region by the air, with which it is congenial, and upon which therefore it does not press; their mutual action destroying the effect of gravity. Earthquakes are caused by the agitation of internal winds and water, or by the decay or sudden fall of columns, that support portions of the earth's surface. Or, the internal winds may be converted into fires, which may cause sudden and violent eruptions, as in mount *Ætna*. Waters passing out of the sea into the crevices of the earth, undergo a filtration, by which the particles of salt received by them from the bed of the sea are separated. Fossils and plants are produced by the motion of atoms, that cause the continual transposition, accretion or diminution of individual bodies. Having no vital principle, they can only be said analogically to live or die. Animals having been once formed, at the beginning of the world, by the casual conjunction of similar atoms, the production of animal bodies is still continued in a consistent and determinate order. The parts of animals were not originally framed for the uses to which they are now applied; but, having been accidentally produced, they were afterwards accidentally employed. The eye, for example, was not made for seeing, nor the ear for hearing, but the soul, being formed within the body at the same time with these organs, and connected with them, could not avoid making use of them in their respective functions. The soul is a subtle corporeal substance, composed of the finest atoms; which, by the extreme tenuity of its particles, is able to penetrate the whole body, and to adhere to all its parts. It is composed

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of four distinct parts; fire, which causes animal heat; an ethereal principle, which is moist vapour; air; and a fourth principle, which is the cause of sensation. These four parts are so perfectly combined as to form one subtle substance, which, whilst it remains in the body, is the cause of all its faculties, motions, and passions, and which cannot be separated from it, without producing the entire dissolution of the animal system. Different sensations are the casual effects of the different organs, which the soul in its union with the body is capable of employing, and of the different properties and qualities of external objects. These become sensible by means of certain species, or images, which are perpetually passing like thin films from bodies, in form similar to the surfaces of the bodies themselves, and striking upon organs fitted to receive them. The mind, or intellect, which is endued with the power of thinking, judging, and determining, is formed of particles most subtle in their nature, and capable of the most rapid motion. This intellect is a portion of the soul, forming with it one nature, and yet retaining its distinct character, which is the power of thinking; the supposed seat of it is the middle of the breast, or the heart, which we perceive to be the region of those affections which are excited by cogitation. Thought is produced by subtle images, which find their way through the body, and, when they arrive at the intellect, move it to think. The affections and passions of the soul may be reduced to two, pleasure and pain. Voluntary motion is the effect of images conveyed to the mind, by which pleasurable or painful conceptions are formed, and subsequent desires or aversions are produced, which become the immediate springs of action. Sleep is produced, when the parts of the soul, which are at other times diffused through the body, are expressed or separated by the action of the air, or of food. Dreams are the effect of images casually flying about, which from their extreme tenuity penetrate the body and strike upon the mind, exciting an imaginary perception of those things, of which they are images. Death is the privation of sensation, in consequence of the separation of the soul from the body; in which case, the soul is dispersed into the corpuscles or atoms of which it was composed, and therefore can no longer be capable of thought or perception. The knowledge of things, which belong to the regions above the earth, whether aerial or celestial, is to be pursued only for freeing the mind from imaginary fears, and settling it in a state of tranquillity. In the heavens, or ethereal regions, the sun, moon, and stars appear to be fiery bodies; or they may be smooth mirrors, from which bright fiery particles flowing through the ethereal regions are reflected to the earth; or they may be deep vessels, containing fires; or they may be circular plates heated like mortar, or stones in a furnace. The apparent motion of the heavenly bodies may arise from the revolution of the whole heaven in which they are fixed, like nails in a solid body: or by the revolution of the bodies themselves through the heaven as a fluid and permeable medium. The cause of this motion may be, either an internal necessity in the natures of the bodies themselves, or the external pressure of some ethereal fluid.

In the universe there are, according to Epicurus, without contradiction, divine natures; because nature itself has impressed the idea of divinity upon the minds of men. The notion is universal, nor is it established by custom, law, or any human institution; but it is the effect of an innate principle, producing universal consent, and therefore it must be true. This universal notion has probably arisen from images of the gods, which have casually made their

way into the minds of men in sleep, and have afterwards been recollected. But it is inconsistent with our natural notions of the gods, as happy and immortal beings, to suppose that they encumber themselves with the management of the world, or are subject to the cares and passions which must attend so great a charge. Hence it is inferred, that the gods have no intercourse with mankind, nor any concern with the affairs of the world. Nevertheless, on account of their excellent nature, they are objects of reverence and worship. In their external shape the gods resemble men; and though the place of their residence is unknown to mortals, it is without doubt the mansion of perfect purity, tranquillity, and happiness.

Upon a review of the preceding summary of the Epicurean system, furnished chiefly by Laetius and Lucretius, it must appear to be a feeble and ineffectual effort to explain the phenomena of nature upon mechanical principles. With this view Epicurus adopts a variety of wild and fanciful hypotheses, which evince his incapacity of solving the grand problem concerning the origin and formation of the world. But the greatest defect of this system is the attempt of its author to account for all the appearances of nature, even those which respect animated and intelligent beings, upon the simple principles of matter and motion, without introducing the agency of a Supreme Intelligence, or admitting any other idea of fate, than that of blind necessity inherent in every atom, by which it moves in a certain direction. Hence he leaves unexplained those appearances of design, which are so manifest in every part of nature, and absurdly supposes, that the eye was not made for seeing, nor the ear for hearing. Besides the idea which he gives of the nature of the gods, whose existence he admits, as similar to man; and of their condition, as wholly separate from the world, and enjoying no other felicity except that which arises from inactive tranquillity, falls infinitely short of the true conception of Deity, as the intelligent Creator and Governor of the world.

The doctrine of Epicurus concerning nature differs from that of the Stoics, (see *Stoics*,) chiefly in the following particulars: while the latter held God to be the soul of the world, diffused through universal nature, the former admitted no primary intelligent nature into his system, but held atoms and space to be the first principles of all things; and whilst the Stoics conceived the active and passive principles of nature to be connected by the chain of fate, Epicurus ascribed every appearance in nature to a fortuitous collision and combination of atoms. See *ATOMICAL* and *CORPUSCULAR Philosophy*.

The ethics of Epicurus are much less exceptionable than his physics; of which we may judge from the following summary. The end of living, or the ultimate good, which is to be sought for its own sake, according to the universal opinion of mankind, is happiness: which men generally fail of attaining, because they form wrong notions of the nature of happiness, or do not use proper means for attaining it. The happiness, which belongs to man, is that state in which he enjoys as many of the good things, and suffers as few of the evils incident to human nature as possible, passing his days in a smooth course of permanent tranquillity. Perfect happiness cannot possibly be possessed without the pleasure that attends freedom from pain, and the enjoyment of the good things of life. Pleasure is in its nature good, and ought to be pursued; and pain is in its nature evil, and should be avoided. Besides, pleasure or pain is the measure of what is good or evil in every object of desire or aversion. However, pleasure ought not in every instance to be pursued, nor pain to be avoided; but reason is to distinguish

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guish and compare the nature and degrees of each, that the result may be a wise choice of that which shall appear to be, upon the whole, good. That pleasure is the first good appears from the inclination which every animal, from its first birth, discovers to pursue pleasure and avoid pain; and is confirmed by the universal experience of mankind, who are incited to action by no other principle, than the desire of avoiding pain, or obtaining pleasure. Of pleasure there are two kinds; one consisting in a state of rest, in which both body and mind are free from pain: the other arising from an agreeable agitation of the senses, producing a correspondent emotion in the soul. Upon the former of these, the enjoyment of life chiefly depends. Happiness may, therefore, be said to consist in bodily ease and mental tranquillity. It is the office of reason to confine the pursuit of pleasure within the limits of nature, so as to attain this happy state; which neither resembles a rapid torrent, nor a standing pool, but is like a gentle stream, that glides smoothly and silently along. This happy state can only be attained by a prudent care of the body, and a steady government of the mind. The diseases of the body are to be prevented by temperance, or cured by medicine, or endured tolerably by patience. Against the diseases of the mind philosophy provides sufficient antidotes; the virtues are its instruments for this purpose; the radical spring of which is prudence, or wisdom, and this instructs men to free their understandings from the clouds of prejudice; to exercise temperance and fortitude in the government of themselves; and to practise justice toward all others. In a happy life, pleasure can never be separated from virtue. A prudent man will consult his natural disposition in the choice of his plan of life. Temperance is that discreet regulation of the desires and passions, by which we are enabled to enjoy pleasures without suffering any consequent inconvenience. They who maintain such a constant self-command, as never to be enticed by the prospect of present indulgence to do that which will be productive of evil, obtain the truest pleasure by declining pleasure. Sobriety, as opposed to inebriety and gluttony, teaches men that nature is satisfied with a little, and enables them to be contented with simple and frugal fare: thus health is preserved; the offices of life are performed with alertness and activity; and the occasional varieties of a plentiful board acquire an excellent relish, and a person is prepared to meet every reverse of fortune without the fear of want. Continence, which is a branch of temperance, prevents the diseases, infamy, remorse, and punishment to which those are exposed, who indulge themselves in unlawful amours. Music and poetry, which are often employed as incentives to licentious pleasure, are to be cautiously and sparingly used. Gentleness, as opposed to an irascible temper, greatly contributes to the tranquillity and happiness of life, by preserving the mind from perturbation, and arming it against the assaults of calumny and malice. Moderation in the pursuit of honours or riches, is the only security against disappointment and vexation. A wise man will, therefore, prefer the simplicity of rustic life to the magnificence of courts. As the events of futurity are uncertain, he neither will be elated with confident expectation, nor depressed by doubt and despair; the one and the other being equally destructive of tranquillity. It will contribute to the enjoyment of life, to consider death as the perfect termination of a happy life, which it becomes us to close like satisfied guests, neither regretting the past, nor anxious for the future. Fortitude, by enabling us to endure pain and banish fear, is of great use in producing tranquillity. Philosophy instructs us to pay homage to the gods, not through hope or fear, but from veneration of their superior nature. It enables us also to conquer the fear of death, by

teaching us, that it is no proper object of terror; since, whilst we are, death is not, and when death arrives, we are not; so that it concerns neither the living nor the dead. The only evils to be apprehended are bodily pain and distress of mind. It becomes a wise man to endure the former with patience and firmness, because, if it be slight it may be easily borne; and if it be intense, it cannot last long. Mental distress commonly arises, not from nature, but from opinion; a wise man, will, therefore, arm himself against this kind of suffering, by reflecting that the gifts of fortune, the loss of which he may be inclined to deplore, were never his own, but depended upon circumstances which he could not command. If, therefore, they happen to leave him, he will endeavour as soon as possible to obliterate the remembrance of them, by occupying his mind in pleasant contemplation, and engaging in agreeable avocations. Justice respects man as living in society, and is the common bond without which no society can subsist. This virtue, like the rest, derives its value from its tendency to promote the happiness of life. It is the interest of every individual in a state of society to conform to the laws of justice, for in society, the necessity of the exercise of mutual justice, in order to the common enjoyment of the gifts of nature, is the ground of those laws by which it is prescribed. Nearly allied to justice are the virtues of beneficence, compassion, gratitude, piety, and friendship. He who confers benefits upon others, procures to himself the satisfaction of seeing the stream of plenty spreading around him from the fountain of his own beneficence; at the same time he enjoys the pleasure of being esteemed by others. The exercise of gratitude, filial affection, and reverence for the gods, is necessary, in order to avoid the hatred and contempt of all men. Friendships are contracted for the sake of mutual benefit; but by degrees they ripen into such disinterested attachment, that they are continued without any prospect of advantage. A true friend will partake of the wants and sorrows of his friend, as if they were his own; if he be in want, he will relieve him; if he be in prison, he will visit him; if he be sick, he will come to him; nay, situations may occur, in which he would not scruple to die for him. It cannot then be doubted, that friendship is one of the most useful means of procuring a secure, tranquil, and happy life.

From the preceding summary of the ethics of Epicurus, we may be enabled to refute the censures which many writers have passed upon him, as the preceptor of luxurious and licentious pleasures. These censures have originated in a misconception of the nature of that pleasure which he recommends and justifies, and which, in his system, is only another name for happiness. Whilst the Stoics taught that virtue itself is happiness, Epicurus maintained, that the motive by which men are induced to practise virtue is the desire of happiness. Both taught, that it is impossible to be happy without virtue, and both supposed virtue to consist in a conformity to nature. Whatever errors and absurdities may be justly charged on the Epicurean system, it must be allowed that, when candidly and fairly interpreted, it afforded no encouragement to immoral conduct. However, it cannot be denied by its most zealous advocates, that by the erroneous representations of the gods, and the disbelief of providence and the immortality of the soul, which this system propagated, it served very much to relax the obligations and enfeeble the sanctions and motives of virtue. This was actually the case both at Athens and at Rome, where those who belonged to the school of Epicurus, partly disseminating his genuine doctrine and partly perverting it, disgraced the system to which they adhered by the laxity and dissoluteness of their manners. Some indeed have expressed

pressed a doubt, whether Epicurus himself disbelieved the immortality of the soul. (See the notes upon "Cudworth's Intellectual system of the Universe," subjoined by Dr. Mosheim to his Latin translation of that learned work, vol. i. p. 66. 500. vol. ii. p. 1174.) His followers, however, seem to have been more explicit on this subject; and Mosheim asserts (Ecl. Hist. v. i. p. 167.) that towards the close of the second century of the Christian era, of all the philosophers, the Epicureans enjoyed the greatest reputation, and had undoubtedly the greatest number of followers, because their opinions tended to encourage the indolent security of a voluptuous and effeminate life, and to banish the remorse and terrors that haunt vice, and naturally incommode the wicked in their sensual pursuits. Hence it is certain, that in the common use of the appellation, Epicurean has been understood to signify an indolent, effeminate, and voluptuous person, who only consults his particular and private pleasure, without concerning himself with any thing serious. Accordingly it has been maintained, that there were always two kinds of Epicureans, the rigid and the remiss. The rigid Epicureans were those who were strictly attached to the sentiments of Epicurus, and who placed their whole happiness in the true pleasures of the mind, resulting from the practice of virtue. The loose or remiss Epicureans, taking the words of that philosopher in a more gross sense, placed all their happiness in corporeal gratifications and pleasures, in eating, drinking, &c. Those of the former class, who were the genuine Epicureans, called the others the "Sophists of their sect." In the "Nouveau Dictionnaire Historique" the reader may find a short account of modern Epicurean schools in France, the members of which were more distinguished by their literary refinement, polished manners, and luxurious indulgence, than their culture of the genuine doctrine of the Greek philosopher.

Before we close this article, we shall briefly trace the subsistence and progress of the Epicurean school, after the death of its founder. From Epicurus the charge of it devolved upon his friend Hermachus; and it was continued in succession by Polystratus, Basilides, Protarchus, and others. The sect subsisted, in a depraved and degraded state, till the decline of the Roman empire. It entered Rome, indeed, in consequence of the opposition excited against it by the Stoics in Greece, under a heavy load of obloquy. This was much increased by the vehemence with which Cicero, (*De Fin.* l. ii. *Tusc. Qu.* l. 1. 3. *Fam. Ep.* xiii. 1. *Orat.* in *Pison.* c. 22.) inveighed against this sect, and by the easy credit which he gave to the calumnies indudtriously circulated against its founder. It was, however, patronized by several persons of distinction in Rome, and particularly by Atticus, the bosom friend of Cicero. Nevertheless, the true doctrine of Epicurus was not fully stated by any Roman writer, till Lucretius, with much accuracy of conception and clearness of method, as well as with great strength and elegance of diction, unfolded the Epicurean system in his poem, "*De Rerum Naturâ*," "*On the Nature of Things*." The Epicurean sect, though much degenerated from the simple manners of its founder, continued to flourish through a long course of years under the Roman emperors. This was owing in part to the freedom of manners which it permitted, and in part to the boldness with which it combated superstition; but principally to the strict union which subsisted among the members of this school, and the implicit deference which they unanimously agreed to pay to the doctrines of their master. The succession of disciples in this sect was, as Laertius attests (*l. x. § 9.*) uninterrupted, even when other schools began to fail. In many places the doctrine of Epicurus was publicly taught, and at Athens

the Epicurean school was endowed with a fixed stipend. Among the learned men of this period there were some, whose whole concern was to transmit the tenets and maxims of Epicurus uncorrupted to posterity; and others, who held the memory of Epicurus in high estimation, and in many particulars adopted his doctrine, and who, therefore, may not improperly be ranked in the class of Epicureans. The principal of these are Pliny the elder, Celsus, Lucian, and Diogenes Laertius. After the revival of letters at a much later period, there were not wanting several learned men, who, finding little satisfaction in the obscure and subtle speculations of metaphysics, had recourse to the doctrine of Epicurus, as the true key to the mysteries of nature. The first restorer of the Epicurean system among the moderns was Daniel Sennert, an eminent physician of Wittenburg, who flourished at the beginning of the 17th century. Sennert, however, confounded the corpuscles of the more ancient philosophers with the atoms of Democritus and Epicurus, and held that each element has primary particles peculiar to itself. The same doctrine was taught, with some inconsiderable variations, by Chrysothom Magnenus, professor of medicine in the university of Pavia, who, in the year 1646, published "*A treatise on the Life and Philosophy of Democritus*." His system is rendered obscure by an attempt to unite the incompatible dogmas of Epicurus and Aristotle. The ablest and most successful attempt towards the revival of the physical and moral philosophy of Epicurus was made by Peter Gassendi, who, besides a variety of other learned treatises, wrote a life of Epicurus, in which he undertakes to rescue that philosopher from the load of calumny under which his memory had lain for many ages, as well as to give a fair and impartial representation of his doctrine. The most celebrated followers of Gassendi were Francis Bernier, a physician of Montpellier, who wrote an "*Abridgement of Gassendi's Philosophy*," Par. 1678, and Walter Charlton, an Englishman, who wrote a treatise, entitled "*Physiologia Epicuro-Gassendo-Charletoniana*," Lond. 1654, in which he attempts to establish natural science upon atomic principles. Indeed, the doctrine of atoms and a vacuum has been embraced by the most eminent philosophers. Huygens applies it to explain the cause of gravitation, and Newton admits it into his theory of natural philosophy. (See *ATOMICAL Philosophy*.) Diogenes Laertius. *l. x.* Lucretius *de Rerum Natura*. Stanley's *Hist. Phil.* part. xiii. Gassendus *de Vita et Moribus Epicuri*. Bayle. art. *Epicurus*. Brucker's *Hist. Phil.* by Enfield.

EPICURUS, in *Biography*, the founder of the system described in the preceding article, was an Athenian, of the Ægean tribe, the son of Neocles and Chærestrata, persons of honourable descent but reduced condition, and born at Gargettus in the vicinity of Athens, at the beginning of the third year of the 109th olympiad, B. C. 342. Neocles, being reduced to poverty, was sent with a colony of 2000 Athenian citizens to the island of Samos, where he occupied a small farm, and took up the profession of a school-master; and where his wife Chærestrata performed the arts of incantation and lustration, for the purpose of curing diseases and driving away spectres, in which, it is said, she was assisted by her son, Epicurus, who furnished her with lustral songs for her solemn rites. Epicurus remained at Samos and in the neighbouring island of Teos, till he was 18 years of age, and then removed, with a view to farther advantage for improvement, to Athens. Upon the death of Alexander, he left Athens, and went to his father at Colophon. Soon afterwards he removed to Mitylene, and after passing one year in that city, he resided for 4 years at Lampascus. In the 36th year of his age, he returned to Athens. From

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his 14th year to this time, he was industriously employed in the study of philosophy. At Samos he was instructed in the Platonic philosophy by Pamphilus, as Cicero informs us (*De Nat. Deor.* l. i. c. 26.), and, as we learn from Clement of Alexandria (*Strom.* l. i.); he attended in his early years upon Nausiphanes a Pythagorean, and Pyrrho the sceptic. During his abode at Athens he could not fail to derive considerable benefit from Xenocrates, who taught in the Academy, and from Theophrastus, who delivered lectures in the Lyceum. His system of philosophy, however, was the result of his own reflections, after comparing the doctrines of other sects. About the 32d year of his age, he opened a school, first at Mitylene, and afterwards at Lamplacus; but not satisfied with these obscure retreats, he determined to make his appearance on the more public theatre of Athens; and purchased for his own use, at the expence of 80 minæ, a pleasant garden, where he taught his system of philosophy. From this circumstance the Epicureans were denominated "the philosophers of the garden." During the siege of Athens by Demetrius, when Epicurus was 44 years of age, and while the city was distressed with famine, he is said to have supported himself and his friends on a small quantity of beans, which he shared equally with them. The period in which he introduced his philosophy was peculiarly favourable for his purpose: for in the room of the Socratic philosophy nothing remained but the subtlety and affectation of Stoicism, the unnatural severity of the Cynics; or the doctrine of indulgence taught and practised by the followers of Aristippus. The younger citizens were, therefore, disposed to listen to a preceptor who smoothed the stern and wrinkled brow of philosophy, and, under the notion of conducting his followers to enjoyment in the bower of tranquility, led them, unawares, into the paths of moderation and virtue. This circumstance rendered his school popular, so that disciples flocked into the garden, not only from different parts of Greece, but from Egypt and Asia. Seneca, though a Stoic philosopher, bears this testimony to Epicurus (*Ep.* 21.): "I the more freely quote the excellent maxims of Epicurus, in order to convince those who became his followers from the hope of screening their vices, that to whatever sect they attach themselves, they must live virtuously. Even at the entrance of the garden they will find this inscription: "The hospitable keeper of this mansion, where you will find pleasure the highest good, will present you liberally with barley cakes, and water from the spring. These gardens will not provoke your appetite by artificial dainties, but satisfy it with natural supplies. Will you not then be well entertained?" The disciples of Epicurus were so cordially attached to one another, that each individual cheerfully supplied the necessities of his brother. The friendship subsisting in the Epicurean fraternity is described by Cicero (*De Fin.* l. i. c. 20.) as unequalled in the history of mankind; and Valerius Maximus (*l. i. c. 8.*) relates a memorable example of indissoluble friendship between Polycrates and Hippoclidés, two philosophers of the garden. Epicurus, that he might not be interrupted in the prosecution of his studies, lived in a state of celibacy; and he exhibited an example of that temperance and continence, which he inculcated on his disciples. Towards the close of his life, however, his constitution was enfeebled, and he was afflicted with the stone. When he perceived his end approaching, he wrote a will, in which he bequeathed his garden and its appurtenances to Hermachus, and in succession to the future professors of his philosophy. On the last day of his life, he informs his friend Hermachus, that his pain was extreme: but he adds, "All this is

counterbalanced by the satisfaction of mind; which I derive from the recollection of my discourses and discoveries." He concludes with intreating his friend by the affection which he had always manifested to him and to philosophy to take care of the children of Metrodorus. The emperor Marcus Antoninus confirms this account, and further says, that Epicurus, in his sickness, relied more upon the recollection of his excellent life, than upon the aid of physicians, and instead of complaining of his pain, conversed with his friends upon those principles of philosophy which he had before maintained. At length, finding nature just exhausted, he ordered himself to be put into a warm bath, where, after refreshing himself with wine, and exhorting his friends not to forget his doctrines, he expired. His death happened in the second year of the 127th olympiad, or B. C. 271, and in the 72d year of his age. He is said to have written a greater number of original works, than any other Grecian philosopher; but none of them are extant, except a compendium of his doctrine preserved by Laertius, and some few fragments dispersed among ancient authors. His memory was held in high estimation, not only by his immediate followers, but by eminent writers, who disapproved his philosophy, but entertained a respect for his personal merit. Nevertheless his character and his philosophy have been severely censured; and the accusations against the Epicurean school have been more or less confirmed by men distinguished for their wisdom and virtue: Zeno, Cicero, Plutarch, Galen, and a long train of Christian fathers. But a candid examination of his doctrine and character will obviate many of those charges that have been alleged against them, and prove, that though in some respects this philosopher is highly censurable, in others he has been unjustly and too severely condemned. The charge of impiety admits of no refutation. The doctrine of Epicurus concerning nature not only militated against the superstitions of the Athenians, but against the agency of a supreme deity in the formation and government of the world, and he divested the Deity of some of his primary attributes. Whilst he professed the utmost contempt for popular superstitions, the gods, whose existence he allowed, were destitute of many essential characters of divinity, and his piety was of a kind very different from that which is inspired by just notions of Deity. Besides, it has been suggested, that his sentiments concerning the gods were adopted and professed for the purpose of avoiding the odium and disgrace which would have attended a direct avowal of atheism. Epicurus has also been charged with insolence and contempt towards other philosophers: but this seems to be scarcely compatible with the general air of gentleness and civility, which appears in his character. The charge of intemperance and incontinence is unquestionably an atrocious calumny. That he was eminent for the contrary virtues has been amply attested by Laertius, and also by those who were adverse to his doctrine, particularly Cicero, Plutarch, and Seneca. Epicurus has been with equal injustice represented as uneducated and an enemy to liberal science. "We ought to be thankful to nature," says this philosopher, cited by Stobæus, "for having made those things which are necessary, easy to be discovered, and those things which are difficult to be known, not necessary."

The temper and character of Epicurus were altogether the reverse of those of Zeno and the Stoics; his mode of instruction was very different; and his school was established in direct opposition to that of the Stoics; and, therefore, we need not wonder, that he should become the object of detraction and calumny. Besides, the design of his philosophy and its general principles were very different, and they endeavoured

to secure their own declining popularity by misrepresenting his principles and character, and holding him up to the public as an advocate for infamous pleasures. For these, and similar reasons, Epicurus encountered the violent opposition of the Stoics; and yet he had many friends and followers during his life, and his memory was venerated after his death. His three brothers, Neocles, Chæredamus, and Aristobulus, devoted themselves to the study of philosophy, and were supported by his liberality. Of his intimate friends the most celebrated were Metrodorus, Polyænus, and Hermachus. After his death his birth-day was celebrated by his followers as a festival; and they preferred his image in their rings or cups, or in pictures, which they either carried about their persons, or hung up in their chambers. Their reverence for his authority was such, that they committed his maxims, and some of them the whole body of his instructions, to memory; and for a long period, it was deemed a kind of impiety to innovate upon his doctrine: so that the Epicureans formed a philosophical republic, regulated by one judgment, and animated by one soul. Laertius, l. x. Brucker's Hist. Phil. by Enfield, vol. i.

EPICYCLE, formed of the Greek *επι*, upon, and *κυκλος*, circle, q. d. a circle on a circle, in the *Ancient System of Astronomy*, was a subordinate orbit, or circle, which moved on the circumference of a larger one, which latter was called the *deferent*. By means of this epicycle, one motion, apparently irregular, was resolved into two that were circular and uniform; and when the observed motion was so irregular and complicated as not to be represented by one epicycle, the method was to add others, till a nearer approximation was obtained. This system owed its origin to a prejudice that seems to have been extremely ancient, in favour of uniform and circular motion; and the problem that chiefly occupied the astronomers in those times, was to assign the proper proportion of the deferent and epicycle which should approximate nearest to the actual observations.

The representation made by this concentric theory of the solar inequalities in longitude, was as follows:

Let C (*Plate XII. Astronomy, fig. 105.*) be the centre both of the earth and of the circle F B D, and let H G K be a smaller circle, called an epicycle, whose centre B moves uniformly in the circumference F B D from west to east, or in consequentia, while the sun moves also uniformly, and with the same velocity, in the circumference of the epicycle, in antecedentia in the upper part, but in consequentia in the lower. If the point G of the epicycle, called the apogee, as being most distant from the earth, be supposed, at the beginning of the anomalistical revolution, to be placed in the point A of O F produced; and if when it comes to G the arch G H be taken similar to F B, the point H will be the place of the sun when the centre of the epicycle has moved from F to B. If then in O F, to which B H is parallel, we take O E = B H, and on E, as a centre, with the distance E A = C F, describe the circle A H P, the sun would be seen from E to move in this circle equably; for the angle A E H is equal to the angle F C B; but seen from C, the centre of the earth, he will appear to move in it inequably, for the angle A C H in the first semicircle of anomaly, that is, in the passage of the sun from A to P, is always less than A E H or F C B: and his true place H will be less advanced in longitude than his mean B. When, again, the centre of the epicycle, or the mean place of the sun, having described a semicircle of the epicycle, will be found in P, the perigee of the orbit A H P, and his mean and true places B and H, will be seen from C to coincide as they did in A, the apogee; but in the sun's passage from P to A, that is, in the second semicircle of ano-

maly, his true place H, as seen from C, will be always more advanced in longitude than his mean place B; for in this semicircle the angle P C H is always greater than P E H in D C B. The angle E H C, or B C H, which is the difference between the mean and true places of the sun, is called the equation of the orbit, as being that quantity which, added to the true motion A C H of the planet in its orbit A H P, in the first semicircle of anomaly, and subtracted from it in the opposite semicircle, will render it equal to the mean motion A E H or F C B; and it is evident that the equation, or difference, will be greatest in N or M, where the centre B of the epicycle is 90° distant from either apsis. Any lines drawn from E, the centre of the orbit A H P, to the true place of the sun in H, and from C the centre of the earth, and of the deferent F B D, to the mean place of the sun in B, are equally called the line of the mean motion of the sun, because these lines are always parallel, and mark the same point in the zodiac; and any line drawn from C to the true place of the sun is the line of the sun's true motion.

It was thus that the ancients originally proceeded in their representation of the solar inequalities, and the representation seemed to be sufficiently justified by observation; at least till the days of Tycho Brahe no observations had been made with sufficient accuracy to subject it to suspicion. Their success also, while no lunar inequality, except the simple anomalistical one, was discovered, was equal in the application of the same concentric theory to the motions of the moon; and having in two cases thus successfully, by means of one subordinate sphere, or epicycle, reconciled apparent inequality of motion with real uniformity, it was natural to suppose that other inequalities, though more various and complicated, might be explained in a similar manner, and required only the addition of other epicycles. The same method of procedure, therefore, was continued, and every new inequality which observation discovered was accounted for by a new sphere, or epicycle, producing it, till the whole number employed in the system amounted to 34. Aristotle, on narrower examination, found these insufficient, and added to them 22: but still they were deemed insufficient, and the number was at last increased to 72; but though it was not till long after the days of Aristotle that the theory was carried to such a degree of extravagance; the multiplication of epicycles rendered it, even in his time, almost as intricate and complex as the appearances which it was intended to explain. Some examples of this kind occur on the revival of it by Copernicus and Tycho Brahe; and when Hipparchus and Ptolemy introduced eccentric orbits, and by means of them somewhat diminished the multiplicity of the spheres employed by their predecessors, they were thought to do a signal service to astronomy. See *EXCENTRIC Theory*.

What was principally required in these theories was to ascertain in the one the ratio of the eccentricity; in the other, the ratio of the semi-diameter of the epicycle to the semi-diameter of the deferent. If we make the radius of Jupiter's deferent circle to that of the epicycle as 52 to 10, the epicyclical motion arising from this construction will very nearly agree with observation: only we may observe, that the oppositions which succeed each other near the constellation Virgo, are less distant from one another than those observed in the opposite part of the heavens; so that the centre of the epicycle seems to move slower in the first case than in the last. To reconcile this with the perfect uniformity of the motion of that centre in the circumference of the deferent circle, the ancient astronomers said that the earth was not exactly in the centre of the deferent, but so

placed that the equable motion of the centre of the epicycle appeared slower, because it is then more remote, and after various trials they fixed on a degree of excentricity for the deferent, which accorded better than any other with the observations, and really differed very little from them. Copernicus shews that their hypothesis for Jupiter never deviates more than half a degree from observation, if it be properly employed. They found that the epicycle moved round the deferent in  $4332\frac{1}{2}$  days, with an equation gradually increasing to near six degrees; so that if the place of the epicycle be calculated for a quarter of a revolution from the apogee, at the mean rate of  $5'$  a day, it will be found too far advanced by near ten days' motion. See Dr. Small's account of Kepler's discoveries, where this subject is treated at great length.

**EPICYCLOID**, in *Geometry*, denotes a curve generated by the revolution of a point of the periphery of a circle, along the convex or concave part of another circle.

A point of the circumference of a circle, proceeding along a plane in a right line, and at the same time revolving on its centre, describes a cycloid. And if the generating circle, in lieu of moving on a right line, moves along the circumference of another circle, whether equal or unequal, the curve described by any point in its circumference is called an epicycloid. Indeed the common cycloid has been sometimes represented as an epicycloid formed by the revolution of a finite circle on an infinite circle.

If the generating circle proceeds along the convexity of the periphery, it is called an upper, or exterior epicycloid; if along the concavity, a lower, or interior epicycloid.

In an epicycloid, the part of the circle the generating point moves along, is called the base of the epicycloid; thus in *Plate V. Analysis, fig. 9.* DC is the base of the epicycloid; V its vertex; VB its axis; DPV half of the exterior epicycloid, made by the revolution of the semicircle VLB (which is called the generant) along the convex side of the base DB; as DPU is the interior epicycloid, formed by the generant's revolving along the concave side of the base.

The length of any part of the curve, which any given point in the revolving circle has described from the time it touched the circle whereon it revolved, is to double the versed sine of half the arc which all that time touched the quietest circle, as the sum of the diameters of the circles to the semidiameter of the quietest circle; provided the revolving circle moves upon the convex side of the quietest circle; but if upon the concave side, as the difference of the diameters to the semidiameter. Otherwise: the circumference of the epicycloid GEF (*fig. 10.*) is to four times the diameter of the generating circle BE, as the sum of the diameters of the two circles is to that of the base, in the former of the cases above mentioned; but in the second, *e.g. seg.* in the same figure, as the difference, &c. In the first case, if the generating circle be supposed to have its diameter equal to half that of the base, the epicycloid FHEG is equal to 6BE. In the second case, when FI is a quarter of FG, the curve Feg will be found equal to 3FI. When the generating circle is half the base-circle, as in *fig. 11*, the epicycloid degenerates into a right line, or the diameter of the base. Hence it appears, that in order to deduce the known property of the common cycloid, or that its circumference is equal to four times the diameter of the generating circle, we need only suppose the base-circle to be infinite: an infinite, augmented or diminished by a finite quantity, being always the same.

Dr. Halley gives us a general proposition for the measuring of all cycloids and epicycloids: thus, the area of a cy-

cloid, or epicycloid, either primary, or contracted, or prolate, is to the area of the generating circle; and also the areas of the parts, generated in those curves, to the areas of analogous segments of the circle; as the sum of double the velocity of the centre, and velocity of the circular motion, to the velocity of the circular motion. The demonstration hereof, see in *Phil. Trans. N<sup>o</sup> 218*.

The areas of epicycloids may be determined by the following proportion: as the radius of the circle of the base to three times that radius together with twice that of the generating circle, so is the circular segment bH to the epicycloidal sector bHF, or the whole generating circle to the whole area of the epicycloid FEGB. As to the tangents, it is known from the time of Des Cartes, that the line Hb, drawn from any point H, to that of the base which touches the circle, whilst this point is described, is perpendicular to the curve, and consequently to the tangent. Maupertuis in discussing this subject, conceived a polygon to revolve upon another, the sides of which are respectively equal, one of the angles described a curve, the periphery of which is formed of arcs of circles, and the area is composed of circular sectors and right-lined triangles. He determined the proportion of the area and of the periphery of this figure to those of the generating polygon. He moreover supposed these polygons to become circles, the figure described to become an epicycloid; and the above-mentioned proportion, modified agreeably to this supposition, gave him the area and the periphery of the epicycloid. *Mem. de l'Acad. 1727.*

The invention of epicycloids is ascribed to M. Roemer, the celebrated Danish astronomer, during his residence at Paris, about the year 1674. These curves appeared to him to be such as best suited the teeth of wheels, constructed so as to diminish their mutual friction, and to render the action of the power more uniform; hence he was led to consider them, and to this purpose they have been applied. However, M. de la Hire in his "*Traité des Epicycloïdes*," printed in 1694, makes no mention of Roemer, and seems to claim the merit of this geometrical and mechanical invention. But M. Leibnitz, who resided at Paris in 1674 and the two following years, says, that the invention of epicycloids, and their application to mechanics, were the work of this Danish mathematician, and that he was esteemed the author of it. It does not appear that any writer published an account of epicycloids before the celebrated Newton, who, in the first book of his "*Principia*" proposed a general and very simple method of rectifying these curves. After him J. Bernouilli, during his residence at Paris, shewed how, by means of the integral and differential calculus, to determine their area, rectification, &c. Many of his "*Leçons du calcul integral*" are devoted to this object. In 1694, M. de la Hire published his "*Traité des Epicycloïdes*;" and in the "*Memoires of the Academy for 1706*" he communicated to the public an extensive and elegant treatise on these curves.

*Spherical* epicycloids are formed by a point of the revolving circle, when its plane makes an invariable angle with the plane of the circle on which it revolves. Messrs. Bernouilli, Maupertuis, Nicole, and Clairaut, have demonstrated several properties of these epicycloids, in *Hist. Acad. Sc. for 1732.*

**EPICYCLOIDS, Parabolic, Elliptic, &c.** If a parabola be made to revolve upon another equal to it, its focus will describe a right line perpendicular to the axis of the quietest parabola; the vertex of the revolving parabola will also describe the cissoid of Diocles; and any other point of it will describe some one of Newton's defective hyperbolas, having a double

a double point in the like point of the quiescent parabola. In like manner, if an ellipse revolve upon another ellipse equal and similar to it, its focus will describe a circle, whose centre is in the other focus, and consequently, the radius is equal to the axis of the ellipse; and any other point in the plane of the ellipse will describe a line of the 4th order. The same may also be said of an hyperbola, revolving upon another, equal and similar to it; for one of the foci will describe a circle, having its centre in the other focus, and the radius will be the principal axis of the hyperbola; and any other point of the hyperbola will describe a line of the 4th order. Concerning these lines, see Newton's Principia, lib. i. De la Hire's Memoires de Mathematique, &c. where he shews the nature of the epicycloid and its use in mechanics. See also Maclaurin's Geometria Organica. For the method of forming the epicycloidal teeth of wheels, see WHEEL.

EPICYEMA, from *επι*, I conceive, a word used by Hippocrates to signify a foetus, or a false conception, or mole coming on after the conception of a former or regular foetus.

EPIDAMNUS, in *Ancient Geography*, a town of Illyria, upon a small promontory between Nymphæum and Petra, built by the Corycæans. Its name, which the Romans considered as inauspicious, was afterwards changed into Dyrrhaicum, now *Durazzo*, which see.

EPIDAURIA, *Ἐπίδουρα*, in *Antiquity*, a festival celebrated by the Athenians, in honour of Esculapius. See *ÆSCULAPIUS*.

EPIDAURUS, in *Ancient Geography*, a town of Greece, in the ancient kingdom of Argos, mentioned by Homer in the enumeration of its ships, and which he represents as fertile in the production of vines. It was situated on the eastern coast of the peninsula of the Argolide, near the Saronic gulf, and opposite to the island of Ægina. This town was celebrated among the ancients for the temple of Æsculapius, situated about a mile from the river, whither the inhabitants of most parts of Europe and Asia resorted for the cure of all distempers. It is pretended that this was the birth-place of Esculapius. (See *ÆSCULAPIUS*.) Antoninus Pius, after having been adopted by Adrian, constructed in this place a temple dedicated to the deities called "Epidotes," and another dedicated to the goddess of health, to Esculapius, and to Apollo, surnamed the "Egyptian." He moreover built a house, for the accommodation of persons who inhabited the district consecrated to Esculapius, and also for lying-in women. He also re-established the portico of Cotys, which had been demolished. The grove of Esculapius near this town was enclosed by two mountains, one called "Titthion," and the other "Cynortion," upon which was constructed a temple dedicated to Apollo Maleates, and upon its summit another dedicated to Diana Coryphæa. In a rotundo near this town were preserved some curious pieces of painting, the performances of Pausias, a famous painter of Sicione, and contemporary of Apelles. The Epidaurians had a beautiful theatre in the temple of Esculapius, constructed by Polycletus, who also built the rotundo at the entrance of the town. Bacchus and Venus had also temples in this town. Epidaurus was also famous for its temple of Diana the Huntress, and a grove consecrated to her, in which was a statue of Epione, supposed to be the wife of Esculapius. In this grove was a superb fountain, splendidly ornamented. In the citadel of the town was a very beautiful statue of wood, which represented Minerva, denominated by the Epidaurians "Cissea." The temple, dedicated to Juno, was on the side of the port, on a promon-

tory which commanded a view of the sea. The Dorians, having been driven from this town by Deiphon and the Argians, united with the Ionians and with them inhabited the islands of Samos and Chios. Epidaurus is now a small place, called "Pidavra."

EPIDAURUS *Limera*, or *Epidaurus Malvesia Vecchia*, i. e. the ancient Malvoisia, is a port of Laconia, seated on the gulf of Argos, now "Golfo di Napoli," S. E. of Zarex. It is pretended that this place was founded by a colony of Epidaurians from the Argolide. Having embarked, as it is said, for the island of Cos, they were driven by contrary winds on this coast of Laconia. They were cautioned in a dream from settling here; but a serpent which they brought with them left the ship and conducted them to the land. This fable was credited in the country, and the worship of Esculapius was established along this whole coast. The Epidaurians thus contrived to obtain a considerable part of the wealth which superstition had accumulated in the Epidaurus of the Argolide; and hence the new town acquired the appellation annexed to it. It was denominated *Limera*, i. e. fished, a name which was not improperly applied to a town, the inhabitants of which contrived to exist at the charge of another. It was built upon an eminence, at the bottom of a small gulf; it was well-peopled, and was famous among other things for its excellent wine, called Malvesy or Malmesy, which grew round the vicinity of it, and with which it supplied other parts of Greece. The most remarkable objects of this place in the time of Pausanias were two temples; one of Venus, another of Esculapius, with a statue of this god. Its port was honoured with the appellation of the "Port of Jupiter Conservator."

EPIDAURUS, a town of Illyria, in Dalmatia, according to Ptolemy and Pliny, the latter of whom gives it the title of a colony; in whose time it was joined to the continent, though, as he says, it had formerly been an island. It is now "Ragusi-Vecchio."

EPIDELICUM, a town of Laconia, on the Argolic gulf, S. E. of Epidaurus.

EPIDELOS, a word used by Hippocrates for a youth in the time of his growth, from the age of seven to that of fourteen. The same author also uses it in a very different sense, expressing by it the observable days in a disease, such as the fourth, eighth, and eleventh, which indicate what sort of crisis is to be reasonably expected on the great critical day.

EPIDEMIA, *Ἐπιδημία*, in *Antiquity*, feasts of Apollo, at Delphos, and Miletus; and of Diana, at Argos.

These feasts bore the name epidemia (from *επι*, in, and *δημος*, people,) because these gods were imagined to be present on those days among the people. Accordingly, on the last day of the epidemia they sung an hymn called *αποπεμπτικός*, to bid them adieu, and set them forwards on their journey.

As those gods could not be every where, and yet were honoured in many different places, there were times allowed them to pass from one place to another, to receive the vows of their adorers. See Scaliger, Poet. lib. iii. cap. 114.

EPIDEMIA were also private festivals, and times of rejoicing, when a friend or relation had returned from a journey. Pott. Archæol. Græc. lib. ii. cap. 20. tom. i. p. 394.

EPIDEMIC DISEASES, from *επι*, and *δημος*, the people, are those diseases which prevail extensively, at different times and seasons, among the inhabitants of cities, or countries: when they occasion great mortality among the persons seized; they are termed *pestilential*.

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The diseases, which are liable to occur epidemically, or to attack a great number of individuals about the same time, or in rapid succession, are principally those of the acute or febrile class. Thus the plague, the sweating sickness, the yellow fever, contagious fever, or typhus, intermittent and remittent fevers, scarlet fever, small-pox, measles, dysentery, catarrh, (denominated influenza under such circumstances,) ophthalmia, hooping cough, &c. are the diseases which have at different times spread over extensive districts epidemically, some of them occasioning the most destructive mortality. Of these the influenza, or epidemic catarrh, appears to be the most extensive in the range which it takes, and the most independent of local causes: in some instances, as in the years 1781 and 1782, this disease appears to have originated in China, and thence to have spread through Asia, to Europe, and in the year following to have visited America.

The other fatal epidemics, such as the plague, yellow fever, and small-pox have been in general the calamities more particularly, though not exclusively, connected with large towns, camps, or other congregations of men. Some of these diseases, as the plague and sweating sickness, are scarcely known except as epidemical; and are altogether unknown, but as diseases of a malignant and fatal tendency: but many of the others, as small-pox, measles, scarlet fever, and typhus, are common and familiar appearances, which seldom cease to exist among us; but which, nevertheless, only occasionally assume those fearful and fatal characters, which belong to them as epidemics.

No circumstance, connected with diseases, has been the subject of more general inquiry, among the physicians of all ages, than this variation in their tendency to spread at one time to multitudes of individuals, to put on a malignant character, and to prove generally destructive; whilst at others they exist in milder forms, affecting few, and destroying scarcely any. Yet the most comprehensive views of the concomitant circumstances, in regard to the obvious conditions of the seasons, and of the moral and political state of the districts, where epidemic diseases arise or disappear, continued with the most minute observation during a succession of seasons, have failed to elucidate satisfactorily this interesting topic. Hippocrates, who has noted with accuracy the peculiarities of various years, together with the prevalent species of disease, attributes the variation of the maladies to a divine something, τὸ θεῖον; which some of his commentators consider as signifying merely the atmosphere at large; but others, among whom is Galen, suppose that he intended to express a latent and inscrutable cause in the air, which produced these surprising effects. (See Hippoc. lib. i. de Prognost. Galen in Com.—also, Sennert. lib. iv. cap. ii. de Causis Pestilentia.) Galen observes, in his commentary upon this point, “non quæcunque causas habent abditas et obscuras, divina vocamus; sed ubi admirabilia videntur duntaxat.” The modern Hippocrates, Sydenham, states, that he had observed with the utmost diligence the different peculiarities of different years, as to the obvious changes and conditions of the atmosphere, with a view to ascertain the causes of the great varieties of epidemic disorders; but that he had not made the smallest approximation to such a discovery; on the contrary, that he had remarked, that seasons of the most decided similarity, in respect to the manifest qualities of the air, were infested by diseases altogether dissimilar; and *vice versa*. “For the constitutions of different years are various;” he says, “yet they do not depend upon the degree of heat or cold, of dryness or humidity, which accompanies them; but probably originate from some occult and inexplicable changes, wrought in the bowels of the earth itself, by which the

atmosphere is contaminated with certain effluvia, which predispose the bodies of men to one or other form of disease. This predisposition continues during the prevalence of the same constitution, which, in an uncertain period of time, is superseded by another.” (Sydenham, sect. i. cap. 2. De Morbis Epidem. See also Van Swieten Comment. ad Aph. 1408.)

From a consideration of the same facts, several writers have attempted to account for these supposed occult changes in the qualities of the atmosphere, which induce epidemic diseases, by tracing them to some of the obvious phenomena of nature, by which such changes may be supposed to be effected. Thus a coincidence has been attempted to be traced between the appearance of comets and of meteors, the occurrence of earthquakes, the eruptions of volcanoes, the conjunction of certain planets, &c.; by all of which it is presumed that some important operations are accomplished in the condition of our atmosphere. Of the effects of planetary influence, indeed, in inducing or diminishing the morbid qualities of the air, nothing is to be found in the writings of the present times: the hypothesis originated and has gone by with the age of astrology. But a very late writer has filled two volumes with evidence, which he believes goes far to prove the existence and operation of some general agent, or *pestilential principle*, throughout the physical world. To this agent he ascribes the origin of earthquakes, and volcanoes, and meteors; and he seems to consider it as the medium by which comets affect the earth, producing tempestuous seasons, great heats, and great colds. (See a brief History of Epidemical and Pestilential Diseases, by Noah Webster, 1800.) This, as a mere hypothesis, would be scarcely less visionary and futile, than the supposition of planetary influence, just noticed. Mr. Webster, therefore, has collected, with great industry, an historical account of the various epidemic and pestilential visitations on record, which have successively occurred to different countries, and has connected with it a chronological view of the appearance of comets, the eruptions of volcanoes, the commotions of the earth, and of the various atmospheric phenomena, which have been described by authors in order to prove their coincidence. “It is certain,” we are told, “that comets have a very sensible effect on the weather;” (loc. cit. vol. ii. p. 122.) and Aristotle, Pliny, and Seneca, are quoted to prove that great heat, tides, and winds, are among the general concomitants of comets. “All the comets,” Mr. W. affirms, “which have approached this earth, in their passage to and from the sun, especially those which have passed very near us, have been preceded, attended and followed by most extraordinary effects, as great heat and drought in summer, and severe cold in winter; deluging rains, violent tempests, and unusual tides. They occur so uniformly, with the appearance of these bodies, and for some months preceding and following, as to leave no room to question the influence from which they proceed.” Ibid. Whatever may occasion extreme variations in the condition of the atmospheric temperature, produce inundations, dearth, &c. will thus remotely, no doubt, induce epidemic diseases, as will be shewn in the sequel. A great number of records are quoted by Mr. Webster, to prove the connection of earthquakes with epidemics (an opinion which many writers have adopted); and also to shew that sensible vapours have issued from the earth, contaminating the atmosphere, about these periods, or sometimes without any earthquakes. From these sensible exhalations an inference is readily drawn of the existence of vapours incognizable by our senses, according to the conjecture of Sydenham. It appears, however, that great pestilence, even when occurring within

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within a short period of earthquakes, has generally appeared before the earthquakes: nor does it occur in the seat of the earthquakes. Thus after the plague in London, in 1665, shocks are said to have been felt on the continent. But Mr. Webster does not conceive this to be any objection to the hypothesis. He believes "that pestilence and earthquakes depend on one common cause; which excites into action the internal fires." But he supposes that "the action or fermentation may precede, for months, and even years, the explosion in earthquakes and volcanoes; and by means of an insensible vapour or heat, or electrical discharges, the elements of water and air may be essentially affected in such a manner as to impair the principle of animal and vegetable life." P. 137.

This hypothesis, which was held by the ancients, (as Claudian writes,

"In cælo nunquam spectatum impune cometam,")

has been adopted by Horstius, Riverius, and echoed by several other writers on the subject of pestilence; but, like many other suppositions upon the same subject, it is altogether gratuitous, and has been received only in the absence of all positive knowledge of the real sources of pestilential diseases. The same observation applies to the supposed influence of earthquakes, and distant volcanic eruptions; more particularly, as the former are allowed to have often followed the effect ascribed to them, and the countries immediately in the vicinity of volcanoes are admitted to have been not more liable to epidemic diseases than other regions.

Two other points have been generally stated as proving the existence of a *pestilential principle*, which is diffused through the atmosphere at large: one is, that trees and vegetables are affected with mildew, and other diseases; the other, that the animal creation also often suffers, when pestilence is committing ravages among mankind. A *rubigo*, or mildew, *i. e.* "a dew impregnated with highly corrosive powers," (see Hird on Pestilence, p. 91.) was anciently deemed one of the causes of epidemic diseases. The Romans, apprised of the pernicious effects of these mildews, instituted what they denominated *Festa rubigalia*, and worshipped an imaginary god, under the name of Robigus. The appropriated sacrifice was a sucking whelp; whence Columella,

"Hinc mala rubigo, virides ne torreat herbas,  
Sanguine lactentis catuli placatur et extis."

Hoffmann mentions such a dew, "ros valde corrosivus," as having infested vegetables in 1693-4, whence the cattle died in multitudes. (Tom. i. de Temp. Ann. Infalub.) And Ramazzini ascribes an epidemic to similar dews; at which time the vegetables, corn, and fruit became black, being affected with a "lues rubigalis." (Constitut. Epidem.) The same year was remarkable for the scarcity of honey; and most creatures that live upon what they extract from vegetables died, or languished. Probably similar occurrences led many of the ancient writers to mention the silence of the grasshopper, and the drooping inactivity of the bee and the silk-worm, among the presages of impending pestilence. As to the spots, which are said to have assumed various forms, especially those of *crucicula*, or little crosses, and to have appeared suddenly on garments, utensils, &c. as they are recorded chiefly on the authority of monks, whose writings are highly tinged with superstition, they are scarcely worthy of serious consideration.

The existence of epidemic disease among cattle is necessarily much connected with the diseased condition of vegetables; and epidemics among cattle seem to have most

commonly occurred after excessive humidity. (Webster.) The calamity among brutes has sometimes proved the forerunner of pestilence among mankind; sometimes its follower; and at other times, they have raged concomitantly: but, in general, their appearance has been remote and unallied. (Hird, loc. cit.)

It is curious, again, and not easily explicable on the principle of a pestilential effluvium, unfriendly to every form of life, pervading the atmosphere, that, while vegetables droop and are mildewed, the grasshopper is silent, the bee and the silk-worm are idle, and cattle die, from its influence, swarms of insects and creatures of other species are said to be among the precursors and attendants of pestilence. It is surely an absurdity to contend for the existence of a poisonous atmosphere, destructive to the life of both animals and vegetables; and at the same time to describe the myriads of noxious insects, frogs, mice, locusts, snails, serpents, and other animals, which appear during an epidemic pestilence! Is one kind of life possessed by man and the animals useful to him, and another by those which are noxious? This contradiction in the hypothesis appears to be very general among writers. The author, whom we have already often quoted, observes, "one thing is very evident, that what I denominate a *pestilential principle* does, at certain times, pervade not only the element of air, but the water also. The proofs of this are abundantly numerous and convincing. In all the great plagues, which have afflicted the human race, other animals, as horses, cattle, sheep, sometimes cats, dogs, and fowls, together with the fish in rivers and the ocean, and even vegetables, have borne their share in the calamity. The pestilential principle has extended to every species of life. The beasts of the field perish with deadly epidemics; the fish die on the bottom of rivers and the sea, or become lean and sickly; while corn is blasted on the most fertile plains, and the fruits in gardens and orchards wither, or fail to arrive at their usual state of perfection." (Webster, Hist. of Epidemics, vol. ii. p. 153.) And immediately afterwards (p. 166.) we are called upon to "attend to the effects of a pestilential" (*i. e.* universally deleterious) "state of air, and in the production of insects and small animals. This is one of the most remarkable symptoms of a *sickly* state of the elements, &c."

It is only against such hypotheses that we have any objection. The fact, that myriads of insects have sometimes been produced, about the time when epidemics prevailed, cannot, we apprehend, be questioned; although probably many of the accounts transmitted to us on this point are much exaggerated. In some instances, such a profusion of insect life may be a result of the same cause with the epidemic, *viz.* extraordinary heat, or heat and moisture: in others, it may contribute to produce the epidemic; by destroying grain and fruits, the food of man; or grass and herbs, the food of cattle, fowls, and other animals which constitute a part of his subsistence. It proves nothing in respect to any occult quality pervading the atmosphere.

Besides, the instances of the copious generation of insects and small animals have not been universal, but partial: some particular species have been generated in profusion; and, therefore, the origin of them must be ascribed to some partial, and not to a general cause. In the plague of Lausanne, in 1613, according to Diemerbroeck, flies were produced in an incredible abundance; as well as during or preceding that of Holland, in 1635. The approach of the plague at Dantzick, in 1709, is said to have been announced by an immense number of spiders in the preceding year. The year 1633, which produced a pestilential fever among the settlers at Plymouth, in America, was remark-

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able for swarms of large flies, which filled the woods with their humming sounds. (Webster.) We cannot but consider, therefore, that the statement above quoted of the universal failure of animal and vegetable life, on the one hand, or the general disposition in the air to generate noxious animals, on the other, as equally erroneous, inconsistent, and absurd. How the individual species of insect or animal is generated, in such cases, or what connection the production of them may have with the pestilence, which sometimes concurs in point of time, we cannot easily ascertain. But where the means of observation fail us, gratuitous hypotheses add nothing to our knowledge.

There are, however, several circumstances which are open to our observation, which, if they do not absolutely produce epidemics of the most pestilential kind, certainly contribute to give them birth, and to aggravate them when produced, and are notoriously the source of epidemics of a less destructive species. Of these obvious causes of the origin or aggravation of epidemic diseases, some contribute directly to excite disease; others to induce, what is scarcely less necessary to their occurrence, a predisposition to them. In fact, the operation of some general agent, inducing a predisposition to be affected by contagion, or other exciting cause of disease, would appear to be the principal source of the predominance of some epidemics. For if the exciting cause never, or scarcely ever, ceases to exist, its occasional activity in inflicting disease among multitudes can only be ascribed to the casual operation of some general predisposing cause, which renders them temporarily susceptible of its influence. This is particularly exemplified with respect to contagious diseases. The contagion of small-pox, measles, and scarlet-fever perpetually exists among us; yet it is only at particular times that these diseases attack so many individuals, as to be called epidemic. In crowded towns, like this metropolis, the infection of typhous fever is perpetually generated in the close, dirty, and unwholesome habitations of the poor: yet there has been no epidemic typhus in London for seven years past. Nay, even the plague itself existed year after year in this city, without spreading generally. It must not be imagined that the disease was accidentally imported just at the periods when it raged so extensively, and with so much destruction. The principal plague-years of the seventeenth century were 1603, 1625, 1636, and 1665; in which the number of deaths from the plague, independent of those from other diseases, are reported in the bills of mortality to have been 36,269, 35,417, 10,408, and 68,596, respectively. But so far was the disease from being extinct in the intermediate periods, that from the year 1603, when the register begins, till 1667, the bills of mortality exhibit only three years entirely free from the plague. It is obvious, therefore, that the presence of infectious matter, or other exciting cause, is not alone sufficient to produce an epidemic disease. Some concurrent circumstances are likewise necessary, to give a predisposition to the human body to be readily acted upon by such cause. Now, some of these circumstances have been well ascertained, namely, particular seasons, marshy and other effluvia, a crowded and filthy population, deficient or depraved aliment, certain passions of the mind, exhaustion of the constitution by fatigue, &c. We shall illustrate the operation of each of these predisposing causes by a few observations.

1. *Seasons.*—The influence of certain seasons, in favouring the propagation of epidemic diseases, has been observed and confirmed by all the medical writers on the subject, from the days of Hippocrates downwards, and was noticed by the earliest poets, even before the time of that great physician; especially the influence of the heats of summer and

autumn, and of the sultry south winds, which blow at those seasons. In many passages of the Iliad, Homer has alluded to these causes of pestilential diseases. Thus, in book v.

“As vapours blown by Auster’s sultry breath,  
Pregnant with plagues, and shedding seeds of death,  
Beneath the rage of burning Sirius rise.” Pope, 1058.

And again in book xxiii. 37.

“Not half so dreadful rises to the sight,  
Through the thick gloom of some tempestuous night,  
Orion’s dog (the year when autumn sways),  
And o’er the feebler stars exerts his rays:  
Terrific glory! for his burning breath  
Taints the red air with fevers, plagues, and death.”

In the first book, pestilence is also ascribed to the anger of Apollo, an allegorical expression for the extreme heat of the sun. (See Pope’s version, lines 83, and 87.)

These poetic statements accord most accurately with the observations of Hippocrates, who frequently mentions epidemic fevers as common in the summer and autumn, and as prevailing most extensively when wet springs with southerly winds were succeeded by hot and close summers. A remarkable constitution of this kind, which continued for two years, is described in his treatise on Epidemics, (*De Morbis Vulgaribus*, lib. iii.) at which time ardent remitting and intermitting fevers of a bad kind prevailed, attended with fluxes, parotids, and eruptions of a pestilential nature. The autumn and spring were wet, close, and cloudy, without wind, the breezes from the south; and these continued during the hot and sultry summer, when the usual refreshing Etesian winds did not blow.

Excessive heat of the summer, without moisture, has occasionally accompanied an epidemic season. Thus in the year of Rome 325, there was a most grievous famine, occasioned by a severe drought, in all the Roman territory. “*Siccitate eo anno plurimum laboratum est; nec cœlestes modo defuerunt aquæ, sed terra quòque, ingenito humore egens, vix ad perennes subfecit amnes;*” the cattle thronged in multitudes round the arid fountains, and perished with thirst, diseases followed among the cattle, from which they were propagated by contagion among men (“*vulgarique contactu in homines morbi*”), the peasantry first suffering, then the lower classes, and at length the whole city was infected. (Tit. Liv. lib. iv. 30.) In more modern times, great droughts have been accompanied by epidemic diseases, especially in cities situated in low and damp countries. In the autumn of 1652, Bartholine informs us that a malignant fever appeared at Copenhagen, after an unusually hot and dry summer. And a similar fever raged at Leyden in the year 1669, as described by Silvius de la Boe. The spring and beginning of summer were cold, but the remainder of summer, and the autumn, were unusually hot, with little or no rain, and with a constant calm or stagnation of the air. (See Pringle on *Dis. of the Army*, p. iii. class 4.)

But epidemic diseases are still more fatal in those seasons, in the damp countries of the south, where the heats are longer and more intense, and much moisture is combined. In some parts of Italy, and in other tracts of the same latitude, epidemic fevers have appeared with such alarming symptoms, as not only to have been called pestilential, but confounded with the plague itself. In this sense we are to understand Celsus, (*De Medicina*, lib. i. cap. 10. lib. iii. cap. 8.) in the terms *pestilentia* and *febris pestilentialis*, which he describes as peculiar to the “grave anni tempus,” and the “graves regiones.” His meaning is, that this bad fever is the disease of the latter part of summer, and of autumn,

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when the air is thickest and most foggy, and that is most frequent in low and marshy countries. Rome was always liable to these fevers. Galen calls the *hemiritea* the epidemic of that city, and speaks of its moist air. (De Temperament. lib. ii.)

In fact the chief malignancy of the worst epidemic diseases, and of the plague itself, has always been felt in the summer and autumn; as the histories of that disease in all the large towns in Europe will testify. Diemerbroeck has justly observed, that when the plague has been excited out of its proper season, it has not spread: and Dr. Russell tells us, that in the winter time, when infected persons have come to places about Aleppo, some of whom have died in the families where they lodged, the distemper by such means was not propagated. In the four great plagues of London, during the seventeenth century, the mortality invariably increased, as the season advanced, reaching its acmè in August and September, and thenceforth gradually declining. (See the Bills of Mortality.—See also Dr. Heberden, jun. on the Increase and Decrease of Diseases, 1801.) Thus in the last plague in London, in the year 1665, the mortality of the respective months was as follows; in the spring very few persons had died of the plague, in June 590 persons died of it, in July, 4,129, in August, 19,046, in September, 26,230, in October, 14,372, in November, 3,349, and in December a few hundreds. (See PLAGUE.) The progress, in the other three instances, was exactly similar.

Again, the regular decrease of pestilential diseases, with the declining summer, equally demonstrates the necessity of the presence of the hot season for their propagation; which may operate either by rendering the contagion more virulent, by producing certain pernicious effluvia from the earth in moist places, or by inducing a predisposition in the human body to receive the influence of those exciting causes. At Grand Cairo putrid and pestilential fevers prevailed annually in March, April, and May, which the southerly winds make the hottest months in that country; but they ceased at the overflowing of the Nile, when the cold winds set in. (Prosper Alpin. de Med. Egypt, lib. i. cap. 14. Mead on the Plague, p. 30.) And “at Smyrna the annual plague constantly ceases about the 24th of July, by the dry and cold weather they always have at that time.” (Mead, p. 56.) Indeed, when this change of season takes place, while every place abounds, it must be presumed, with the contagion, yet it ceases to be detrimental. Prosper Alpinus remarks, that when this change of season comes, in the month of June, even the clothes imbued with the most pestiferous contagion then infect no one. “Sed quod valde mirabile creditur, omnia supellectilia pestifero contagio infecta tunc nullum contagii effectum in eam gentem edunt.”—And this inertness of the contagion in the most infected places, on the approach of winter, was most remarkable in the last plague of London. “Many who made most haste in retiring,” says Dr. Hodges, “made the most to return, and came into the city without fear: inasmuch, that in December they crowded back as thick as they fled: the houses, which were before full of the dead, were now again inhabited by the living; the shops, which had been most part of the year shut up, were again opened, and the people again cheerfully went about their wonted affairs of trade and employ: and even what is almost beyond belief, those citizens, who before were afraid even of their friends and relations, would, without fear, venture into the houses and rooms where infected persons had but a little before breathed their last: nay, such comforts did inspire the languishing people, and such confidence, that many went into the beds, where persons had

died, before they were even cold, or cleansed from the stench of the diseased.” (Joimologia, or Hist. Acc. of the Plague in 1665, p. 27.) In the same way we read, that when the plague was in Italy, the Neapolitans used no artifice to purify either their goods or houses; yet the disease ceased among them as entirely as in the best regulated towns. (Heberden, loc. cit.)

These facts amply prove the extensive influence of certain seasons, in favouring and interrupting the progress of the most pestilential epidemics; and that not in consequence of any occult, but of certain sensible and obvious conditions of the weather. The same circumstances of the seasons modify the propagation and diminution of the minor epidemics, such as dysentery, remittent and intermittent fevers, &c. and even the small-pox: Of the former of these, we shall more properly speak under the second head of causes; namely,

2. *Marshy and other Effluvia.*—Galen assigns two causes for pestilential fevers; the first of which is great heat of the weather, and the second, which he considers as most frequent, a corrupted state of the air, arising either from a multitude of dead bodies left unburnt, as after a battle, or from the evaporation of corrupted lakes and marshes. (De Febr. Diff. lib. i. cap. 4.) Other authors of antiquity have noticed the coincidence of epidemic fevers with marshy situations. Thus Diodorus, the historian, has recorded the occurrence of a pestilential disease among the Carthaginians at the siege of Syracuse, which he attributes to the combination of the following circumstances; the multitude of people confined within a narrow compass, the situation of the camp in a low and wet ground, and the scorching heats in the middle of the day, succeeded by cold and damp air from the marshes in the night. (Bibl. Hist. lib. xiv. cap. 70.) In more modern times the origin of epidemic diseases from marsh effluvia had been very generally observed. Fracastorius ascribes a malignant epidemic fever, in Italy, in the sixteenth century, to an extraordinary inundation of the Po, which, happening in the spring, left marshes, and those corrupting infected the air through the summer. Forestus remarks, that, from the putrefaction of the water only, the city of Delft, where he practised, was scarcely ten years free from the plague or some pestilential distemper. (Observat. lib. vi.)

The effects of marsh or putrid effluvia in giving rise to epidemic diseases have, indeed, been evinced in most of the large cities, and still more obviously in the camps of modern times. Sir John Pringle, speaking of the hot weather, during one of the campaigns in the Netherlands, in 1748, observes, that though the heats were great, yet they were the cause of little sickness, till the troops were cantoned in the marshes, where a considerable degree of putrefaction and moisture being joined, ardent, remitting, and intermitting fevers, and fluxes became general. It is remarkable that these pernicious exhalations do not rise high, nor spread far from their source, at least without such dilution as diminishes their deleterious qualities. Dr. J. Hunter has affirmed, that in the barracks at Spanish Town, in Jamaica, (which consisted of two floors, the first upon the ground, the second over the first,) the difference in health of the men on the two floors was so great as to engage the attention of the assembly of the island, and upon investigation it appeared that three were taken ill on the ground floor for one on the other. Even at a few hundred feet above the level of the marshes, the situations are extremely healthy. (Observ. on the Dis. of the Army in Jamaica, note B. p. 268, 3d edit.) The air of a marsh or of a foul camp, the same author observes, may destroy an army almost as soon as the true plague. But the remedies

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in such cases are obvious, and consist in getting at a proper distance from the noxious exhalations, or removing the causes of them. "A very small space frequently includes the limits of healthy and unhealthy ground." It is not now necessary to state that agues, or intermittents, originate solely from the effluvia of marshes.

Another species of effluvia, which is the source of epidemic diseases in camps and in towns, when ill constructed and neglected, arises from ground contaminated with human and other excrements, the remains of victuals, the water used in cookery, for washing, the foul straw rotting in tents, &c. Whenever a camp remains long on the same ground, especially in hot and moist weather, fluxes, and intermitting and remitting fevers, seldom fail to become epidemic, unless great precautions are used to bury all excrementitious matter, and proper receptacles and drains underground are prepared for the urine, water of cookery, &c. (See Dr. Hunter, *loc. cit.* p. 285.) In this case, however, as in that of marsh effluvia, the diseases produced will disappear, by moving the camp a few hundred yards from the foul ground.

These facts throw great light on the epidemics of large cities, which were formerly so frequent and fatal. A large town may be considered as an extensive camp, but destitute of the means of changing its situation, and, consequently, liable to be infested with the same diseases as are endemic and epidemic in camps, unless the precautions just alluded to, for the purpose of removing the sources of the pestilential effluvia, be fully adopted. And we find, accordingly, that during and previous to the 17th century, (and even later, in some countries,) the large towns were almost constantly infested, in the summer and autumnal months, with the plague, malignant, intermittent, and remittent fevers, and dysentery; the same disorders to which camps are liable. This was the condition of London during the period specified. We have already remarked, that the plague was seldom absent from the beginning of the 17th century to the year 1669, and that four dreadful visitations of that calamity occurred within the same space of time. Of the extent to which intermittent and remittent fevers prevailed, in this metropolis, we have also ample evidence. Dr. Short remarks, that early in the century, *viz.* between 1629 and 1636, "one of 40 of the whole that died of fevers, died of agues;" whereas, "now (1750) scarce one of 1100 that die of fevers die of this disease." (New Obs. Nat. Moral, &c. on Bills of Mortality, 1750, p. 208.) Burnet, in his "History of the Reformation," says, that in the last year of queen Mary's reign "intermitting fevers were so universal and contagious, that they raged like a plague." Both Sydenham and Morton have left us abundant evidence of the frequent epidemic prevalence of agues, as well as of remittent fevers, which last Morton affirms to have been extremely destructive for several years before the great plague, *viz.* from the year 1658 to 1664. He states that Oliver Cromwell died of this fever in 1658; and that his own father, himself an experienced physician, also died of it; when his whole family, the writer included, were infected. (Morton, *Pyretologia*, App. ad Exercit. ii.) Even so late as from 1720 to 1729, according to Dr. Short, "they (intermittents) and remittents afflicted the whole nation grievously."

Sometimes together, and sometimes alternating with those autumnal fevers, the dysentery was a frequent epidemic in London, in the times to which we allude, and was often attended with great fatality. For five and twenty years successively, from 1667 to 1692, the bills of mortality shew the sum of deaths under the titles of "bloody flux," and

"gripping in the guts," which must both be considered as dysentery, to have amounted every year to above 2000. During the last century, the disease has gradually declined, (Dr. Heberden on Increase and Decrease of Diff. Diseases, p. 34.) and the other fatal epidemics, just mentioned, have quite disappeared. See Annual Medical Register for 1803, vol. i. where the changes of disease in London are discussed at length.

We cannot doubt, that the present comparative healthiness, and especially the great freedom from all epidemics (the contagions of small-pox, scarlet fever, and measles excepted) which this metropolis now enjoys, is to be ascribed altogether to the measures, by which the sources of the effluvia, which excite them, have been removed, and to the general habits of cleanliness and ventilation which are at present observed by the people. These salutary measures are principally the construction of privies, drains, and common sewers; a hard and regular pavement, with a proper level for carrying off the humidity, and well cleansed by scavengers; an abundant supply of water to every part of the town, &c.

In all these points, the condition of London, like that of most other large cities in Europe, during the 17th century, was extremely defective. In the preceding centuries its condition must have been still more incommodious and filthy, so that few years elapsed without the occurrence of a considerable pestilence. We have not room, in this place, to enter more at large into a description of its circumstances; but must content ourselves with referring to the work of Dr. Heberden, *jun.* just quoted, where an abundant collection of evidence, as to the connection of those epidemics with filth and negligence in the economy of this and of other large towns, will be found. (See also the Ann. Med. Register for 1808. Maitland's and Nourthouck's History of London.) See **PLAGUE.**

It is extremely gratifying, both in a physical and moral point of view, to observe that the same means which contribute to our personal comforts, and to elevate us above the savage, *viz.* the progress of civilization and refinement, have led to banish the most loathsome and fatal distempers, to prolong life, and to diminish the prevalence and fatality of other diseases of less fatality. "While the metropolis has extended itself in all directions, and multiplied its inhabitants to an enormous amount, *i. e.* while the apparent causes of its unhealthiness have been augmented, it has actually become more favourable to health. In the year 1697, for example, the total mortality of London was 20,970; whereas, the total mortality of 1797 amounted only to 17,014: and when we take into consideration the great increase of the population of the out-parishes at the latter period, the comparative healthiness of London will appear in very strong colours." Ann. Med. Register, p. 321.

Sometimes the air of a particular district seems to have been impregnated with effluvia from putrefying animal and vegetable matter, which has occasioned an epidemic in that neighbourhood. Forestus has mentioned the putrefaction of a large fish, of the whale kind, which was left by the tide, and died, on the coast of Holland, and, during its putrefaction, infected the country with a horrid stench, in consequence of which a fatal epidemic fever broke out in the district of Egmont. (Obs. lib. vi. 9. tom. i.) The same author informs us of a pestilential fever, which raged at Venice in his time, and was produced by the corruption of a small kind of fish in that part of the Adriatic. (Ibid.) Instances are also on record of epidemic fevers occasioned by the effluvia of putrid cabbages, as well as of plants

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plants in marshes. (Rogers on Epidem. p. 41.) These sources of epidemics, however, are rare, and can seldom occur under a well regulated police.

3. *A crowded Population.*—From the earliest periods of time, of which we have any record, pestilential diseases were known to be the effect of crowded population, and to rage peculiarly in cities, forts, and other confined places. In the sacred writings pestilence is every where mentioned as the peculiar scourge of cities. “The sword is *without*,” says the prophet Ezekiel, chap. vii., “and the pestilence and famine *within*; he that is in the field shall die with the sword; and he that is in the *city*, famine and pestilence shall devour him.” And again, chap. xxxiii., it is said, “they that be in the *forts* and the caves shall die of the pestilence.” The city of Rome was subject to the most fatal epidemics from a very early period of its history: Athens suffered also extremely; and in modern Europe the great cities have been the common seats of plagues, from Constantinople to Moscow, and from Cadiz and Marseilles, to Copenhagen and Dantzic. (See an enumeration of the cities infected with the plague, and the dates of its occurrence, by Dr. Heberden, *loc. cit.* p. 81, *et seq.*) The same observation applies to the cities of Asia and Africa; to Aleppo, Cairo, &c. &c., as well as to those of America.

We have already stated, that the prevalence of epidemic and pestilential diseases in this metropolis was obviously connected with the existence of filth of every species, and that their gradual disappearance has been coeval with the improvements of the city, and the removal of these nuisances. The same fact is observable in all the cities of Europe: and those which, from natural or political causes, have been backward in adopting the improvements of modern times, have more lately exhibited the same effects of their negligence. The plague appeared at Copenhagen in 1764; and at Moscow so late as the year 1771. It is farther observable, that pestilential diseases generally appear first in the most crowded and uncleanly parts of towns, and rage most severely in the most crowded and dirty habitations, *i. e.* among the poor. The plague of 1665, in London, is said to have been by many persons called “the poor’s plague.” Those of 1626 and 1636 broke out at Whitechapel, a part of the town which abounded with poor, and with slaughter-houses: and that of 1665 is said to have broke out first at St. Giles’s; and there, Dr. Heberden remarks, it would probably break out again, if ever we should suffer such another calamity.

For it must be observed, that a crowded and uncleanly population contributes, in a double manner, to the origin and propagation of epidemic and pestilential diseases. It not only occasions the accumulation of every species of filth externally, from which effluvia arise to contaminate the atmosphere, in hot and moist seasons, thus producing all the diseases of camps; but it produces another species of effluvia, internally, in the habitations of men; *viz.* from the bodies of the sick, and even of the healthy, which at once generate malignant fevers, and aggravate those which arise from the other sources. (See *CONTAGION*.) So that under the circumstance of the combination of these causes, namely, when the heat and moisture of autumn generate the effluvia from external filth, and contagion is superadded from the accumulation of the corporeal effluvia, from the want of internal cleanliness and ventilation, diseases of an epidemic nature are readily excited, and are propagated extensively and fatally. Hence, before the value of these internal cautions was understood, malignant fevers so frequently occurred in hospitals and gaols, that they obtained the appellation of hospital-fever and gaol-fever. Indeed we are told

that, so late as the latter end of the 17th century, in the gaol of Newgate, a contagious fever used to break out annually, in hot weather; and that the same was true of most gaols in Europe; (The City Rembrancer, quoted by Dr. Heberden) and several facts on record, prove, how readily any acute disease is thus propagated by contagion, under these circumstances of crowded and filthy habitations; although originally, and in cleanly and airy apartments, it was incapable of spreading from one individual to another. Thus sir John Pringle observed, that, “in autumn 1757, several soldiers were brought into the hospital at Portsmouth, with a disorder compounded of the autumnal and gaol-fever; for when these men, upon being seized with the common fever of the season, were confined to the holds of the crowded transports, their distemper assumed that form. (Dis. of the Army.) So Dr. Lind has stated, that, upon admitting into an hospital one person with a flux, several other patients in the same ward have had this symptom added to their other complaints. (Lind on Fever and Infection.) And Dr. Blane has observed generally, that, supposing a ship’s company be predisposed to acute distempers, and one man or more ill of a dysentery be brought on board, this will become the prevailing disease. (On the Diseases of Seamen.)

These facts, which evince the facility with which any acute disease, or its leading symptom, is communicated from individual to individual, in a close and crowded apartment, when extreme cleanliness and ventilation are not attended to, will serve to explain several apparent anomalies in the history of several diseases, which have been stated as the result of some mysterious epidemic principle in the atmosphere. We allude to the occasional spreading of particular maladies in hospitals, in a sort of epidemic way; such as the appearance of erysipelas, connected with all slight injuries of the scalp, or other superficial parts, as related by sir William Blizard, of the London hospital, and as occurred in the surgical ward of the Royal Infirmary, at Edinburgh, many years ago; the disposition to inflammation and abscess about the perineum and neighbouring parts, mentioned by the same writer, &c. (See a Paper “On some epidemical Effects,” Med. Facts and Obs. vol. ii. 1792.) Such occurrences, we believe, are rare in proportion to the degree of cleanliness in those receptacles of the sick. We have been assured that the occurrences of this nature at Edinburgh have ceased, since a more rigid ventilation and purification have been adopted in the Royal Infirmary.

4. *Deficient and Depraved Aliment.*—The obvious causes of epidemic diseases, already mentioned, may operate both as exciting and as predisposing causes; but that to which we now direct our attention, perhaps, chiefly acts in inducing a debilitated and half-morbid condition of the body, which renders it liable to be affected by those exciting causes. Certain it is that famine and pestilence have been observed to go together, since the earliest ages of the world; and are constantly mentioned in combination, in the sacred writings; to which war is frequently added. Dearth is almost necessarily a part of the desolation of war; which, therefore, contributes to the production of pestilence indirectly by producing dearth. *Ὁ λοιμὸς μετὰ λιμοῦ*, “the plague after famine,” was an old Greek adage. Where articles of food are extremely scarce, they are often also corrupted, and may thus contribute to reduce the human constitution to a state predisposed to disease. Forestus imputes the plague at Delft, in the year 1557, to the eating of mouldy grain, which had been long kept up by the merchants in a time of scarcity. (*Loc. cit.*) And sir J. Pringle says, he had heard it observed, that in this island the dysentery is frequent among the common people, in those parts where they

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live mostly on grain, when the preceding crop has been damaged in a rainy season, or kept in damp granaries. (*Loc. cit.* cap. vii. p. iii.) In ancient times the corruption, as well as scarcity of food, was assigned as the cause of pestilence; as by Cæsar himself when besieging Marseilles, (*De Bello Civili*, lib. ii. 20.) "Panice enim vetere, atque hordeo corrupto, omnes (*scil.* Massilienses) alebantur; quod ad hujusmodi casus antiquitus paratum, in publicum contulerant." When we advert to the fatal epidemic disease, termed *Leu sacrè*, *Mal des ardens*, &c. by the French, and known to originate from *ergoted* rye, used as food, we shall not hesitate to ascribe considerable effects to the sort of food just mentioned. (See *Philos. Transact.* vol. lv. p. 110, and *Mem. de la Soc. Royale de Medecine*, for 1776.) Dr. Willan has observed, that the *Morbus Hungaricus*, described by Sennertus, "and some other diseases reputed pestilential, might be added to the list of epidemics, occasioned by the *ergot*; or by a similar degeneration in other grain. The sweating-sickness, which occurred more than once in England, at the beginning of the sixteenth century, was perhaps owing to some disease or depravation in wheat, &c." (*On Cutaneous Diseases*, part iv. p. 499.) It may be added, that the only epidemic occurrence of contagious fever in London for several years back, occurred after the excessively wet autumn of 1799, when corn was exceedingly damaged, and a considerable scarcity ensued.

5. *Exhaustion by Fatigue, &c.*—Besides the debility of constitution, and consequent predisposition to disease, induced by imperfect nourishment, during a famine, the exhaustion produced by excessive corporeal exertions, loss of sleep, and the depressing passions, probably contributes in no small degree to predispose the body to diseases. Thus epidemic fevers have been observed to arise after great battles. Dr. Gottward traced the origin of the plague at Dantzick to Pinow, soon after the battle of the Swedes and Saxons, in 1702. (*Ingram, Hist. of Plagues*, p. 86.) To the same cause, perhaps, we may impute the contagious fever, which raged among the troops of the late sir John Moore, on their return from the harassing campaign in Spain. (1809.) Van Swieten observes, that "strong passions of the mind, particularly terror, augment the efficacy of infection, as all writers on the plague unanimously allow," and that the same passion contributes to render the disease more fatal. If this be correct, the extensive operation of fear in besieged towns, and countries which are the seat of war, must produce considerable influence; and it cannot be doubted, that the general panic, which rapidly spreads among the inhabitants of a town, where the plague is discovered to exist, contributes materially to its propagation.

On reviewing the facts above stated, it is obvious that the sources of epidemic and pestilential diseases have been often traced to manifest circumstances, in combination with one or more of which they have generally been observed to occur: and more especially that the heats of summer and autumn appear to be absolutely necessary to the propagation of a general pestilence. The observation of Celsus, in regard to the salubrity of the different seasons, has been confirmed by those who have practised in warm climates, (*Cleghorn on diseases of Minorca*) by the physicians of camps, (*Pringle, loc. cit.* part ii. chap. i.) and by the condition of this country in the time of Sydenham. "*Saluberrimum ver est; proxime deinde ab hoc, hiems; periculosior æstas; autumnus longe periculosissimus.*" (*Celsi De Med.* lib. ii. cap. i.) But the experience of the last century, during which this order of the seasons, in point of salubrity, has been almost reversed, (for we now find July and August the most healthy months of the year, and February and

March the most productive of disease,) has thrown considerable light even on the occult principle, the *to be*, of the epidemic atmosphere. It has shewn us, what Sydenham could not have anticipated, and what to him indeed must have been incredible, that, while the seasons continue to occur, with their former vicissitudes, and while the bowels of the earth (for aught that we know) continue to send forth their vapours as usual, yet those fatal pestilential constitutions of the air no longer appear; the plague has not been seen, since the rebuilding of the city (1667); intermittents no longer infect the metropolis, and the autumnal remittents are alike almost unknown; especially since the covering of Fleet ditch, and the other improvements, made in 1766; and the dysentery, or bloody flux, now scarcely adds twenty to the annual bills of mortality! This occult principle, then; this epidemical *somewhat*, it must be inferred, neither owed its origin to the atmosphere, nor to the bowels of the earth, nor to the eruptions of *Ætna*, nor to the approach of comets. For the former of these are, doubtless, unchanged; and the latter have continued to occur at intervals as usual.

To what, then, are we to attribute the origin of those epidemic constitutions, as they have been called, of particular years, in which certain diseases extensively prevail? We have not, perhaps, a sufficiency of facts to enable us to deduce a decided conclusion; but the following inference seems to approximate to the truth, and to spring out of the facts already detailed.

The experience of camps, especially in moist seasons, teaches us how readily epidemical diseases are produced, from the contamination of the lower portion of the atmosphere with the effluvia of foul ground, and also how confined and local that contamination is, since a small elevation, or a removal to the distance of a few hundred yards, from the source of the effluvia, is sufficient to enable us to escape their noxious effects. The experience of gaols and hospitals, and other crowded and uncleanly habitations, has also demonstrated the facility with which human effluvia, accumulated about the sick, become contagious to those in their immediate vicinity; and also how readily, in this predisposed and contagious state, any acute disease, accidentally introduced, is carried from individual to individual, so as to become the prevalent or epidemic disease. Now, London, and all other crowded cities in the 17th century, combined within themselves both these peculiarities of condition, belonging as well to camps as to gaols and hospitals. The atmosphere was contaminated with the local effluvia, which rendered it pestilential externally; and, within the dwellings, especially in the poorer parts of the town, infectious atmosphere was produced, and thus whatever disease was generated, was propagated readily, and gave a character to the particular constitution of the epidemic season. How variously the epidemics must be modified, according to the various degrees and combination of the exciting and predisposing causes, must be obvious on reflection. When the bodies of the people happen to be pre-disposed to disease by want of food, or actually disordered by corrupted food, when the accumulation of filth, or the increase of marshy ground from rains or inundations, send forth miasmata in a most abundant and concentrated form, in consequence of a peculiar autumnal season, the most extensive epidemic diseases may be expected to arise. And we believe, that under such a combination of obvious circumstances, pestilence never fails to appear.

On the other hand, although a large city cannot, like a camp, be removed from the source of the pestilential effluvia, which it generates, yet industry may remove the source of these effluvia from it. And it appears to be a perfect

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perfect confirmation of the preceding conclusions, that, as this removal has been accomplished in London, (for example,) as the arts of peace and civilization have advanced, and wealth has introduced the disposition and the power to multiply personal comforts and conveniences; and as habits of cleanliness and ventilation have been generally diffused; in the same proportion, and with equal steps, the improvement of the general health, the absolute disappearance of the plague and the other epidemics, and the increase of longevity, are to be remarked. Hence it is only within the last few years, that the deaths have fallen short of the number of births within the bills of mortality of London.

We cannot, from our present knowledge of facts, however, account for all those modifications of diseases, nominally the same, which are observed to prevail at different seasons, and which require different modifications of the treatment. It can only be stated as highly probable, that whether the epidemic diseases originate from contagion, or human effluvia, or from the effluvia of foul ground, their degrees of violence may depend on the degrees of concentration of those effluvia; and the contagion of a mild or severe disease may tend to propagate more particularly a disease of similar character. We have already seen that peculiar symptoms, superadded to an acute disease, as affections of the lungs or of the bowels with general fever, are readily propagated along with that fever, and have modified both its character and the requisite treatment.

It has been justly observed, that "in military physic," (and the observation applies to epidemic diseases in general,) "the great improvements to be made are not so much in the cure as in the prevention of diseases, which depends altogether upon the knowledge of their causes." (Dr. John Hunter, *loc. cit.* p. 281.) Now one of the most important circumstances to ascertain, during the prevalence of an epidemic is, whether it arises from contagion, that is, from the influence of effluvia from the bodies of the diseased, or from the contamination of the air by the effluvia of foul ground, &c. For "if a disease arise from contagion, as the author just quoted remarks, "there are sure remedies against it, which are so well ascertained, that while the plague, the most contagious and the most fatal of all diseases, commits its greatest ravages in large cities, individuals remain in the midst of them in perfect security, trusting to a careful seclusion under proper regulations. (See CONTAGION.) Again, if disease arise from the air contaminated by the foul ground of a camp, or the exhalations of a marsh, it can only be avoided by a change of situation, or by taking care not to come within the sphere of activity of such noxious causes." Or in a large town, it may be added, by a strict enforcement of public and private cleanliness. But it is often extremely difficult to decide upon this point; a generally operating cause affects such a number of individuals about the same time, in the same situation, that they may seem to be infected by each other. So that, in fact, it has been disputed whether the plague itself be a contagious disease; and in regard to the dreadful epidemics of America, medical observers are by no means agreed as to their contagious origin. The contagion of the plague will be discussed hereafter. In the mean time we shall state some observations which may help to guide our decision in such cases.

By a contagious disease, is to be understood a malady in the course of which a poison is generated in the body of the sick, which produces in others a similar disease. The poison in some diseases, as the small-pox and chicken-pox, is sufficiently apparent; and the other diseases, which also arise from specific contagion, and occur but once during

life, as measles, scarlet fever, hooping-cough, &c. are well known. In others, again, as in typhus and the plague, it almost eludes our senses, and is only active when concentrated or accumulated, or close to the body of the sick. Now these contagious diseases equally affect all ages and descriptions, who suffer exposure to their cause: wherever they prevail, the old inhabitants of a country suffer as much as those that have lately arrived. But this is never the case in the yellow fever, remittent fever, or even intermittent fever, which arise from external miasmata; for such as are seasoned to the country or climate suffer infinitely less than newcomers. Again, diseases proceeding from such a cause, generally diffused, and operating upon all, do most constantly recur in the same persons as long as they remain exposed to the original cause; thus in camps and marshy situations, the sick are constantly relapsing in remittents and intermittents, till they change their situation. Dr. Hunter particularly observes, that the mortality among soldiers in the West-Indies is, in a great measure, owing to these repeated attacks. But what the same writer considers as the *experimentum crucis*, to prove the non-existence of contagion, is, when the sick leave their usual residence, and go to other places which are healthy, without spreading the disease. This constantly happens in the remittent fevers of the West-Indies; for the good effects of changing the air of the towns for that of the mountains is so well known, that it is very generally practised; but certainly without the slightest suspicion of any mischief arising from any contagion carried by the sick. If we try by this rule the fever epidemic in Philadelphia in 1793, we shall not pronounce it to be contagious. One observation more may be added: when disease arises from a cause generally diffused, separation, which in contagious diseases is commonly effectual, is here of no avail. Thus, ships of war have gone into a harbour in the West-Indies, and have had no intercourse with the people on shore, or with the crews of other ships, and yet in a few days the men have been seized with the prevailing fever in great numbers. (Hunter, *ibid.*)

With respect to the last argument but one, indeed, the inference is not perfectly conclusive; for malignant typhoid fevers, (and the plague, which is probably but an extreme degree of the same fever,) although they produce a contagion that is active and virulent in a confined and close atmosphere, nevertheless become much less contagious, in a clear and open air; so that we should expect that, on a removal of the sick to the country, the disease would assume a less virulent form. In the plague at Moscow in 1771, we are told by Dr. Mertens, that the patients, who were conveyed to the neighbouring villages, communicated the disease to the inhabitants of those places; which they would the more readily do, as probably their cleanliness was not superior to that of Moscow itself.

The specific contagions, as they have been called, as small-pox, measles, and scarlet-fever, which occur but once in the course of life, and chiefly attack children, become epidemic generally at pretty regular periods, in large towns. This may be principally explained, perhaps, by the circumstance of the necessary interval requisite for the production of subjects, who have not undergone these diseases.

On the whole, however, although the progress of refinement in the comforts of human life, during the last century, have thrown much light on the nature and origin of epidemic constitutions, in different years; it must be allowed, nevertheless, that much farther observation of facts will be requisite, in order to illustrate the subject completely.

**EPIDENDRA**, from *επι*, upon, and *δενδρον*, tree, in *Natural History*, a word used by Sir Hans Sloane, and some other authors, to express those plants which grow upon others, such as the mistletoe, which grows upon the apple-trees, &c. These are more commonly distinguished by the name of parasitical plants. See **DODDER**.

**EPIDENDRUM**, in *Botany*, so named by Hermann, Linnæus, and others, from *επι*, upon, and *δενδρον*, a tree, because most of the species, if not all, grow parasitically on the trunks or branches of trees. Linn. Gen. 464. Schreb. 606. Willd. Sp. Pl. v. 4. 114. Mart. Mill. Dict. v. 2. Juss. 66. Swartz. Act. Holm. 1800. p. 240. Tracts on Botany, 182. Schrad. Journal, 1799. 209. t. 1. Orchid. in Schr. Neues Journ. v. 1. 79. Class and order, *Gynandria Monandria*. Nat. Ord. *Orchideæ*, Linn. Juss.

Gen. Ch. reformed. Cal. three-leaved. Cor. Petals two, nearly equal to the calyx-leaves, spreading; nectary a lip, turbinate and tubular at the base, connected with the style, destitute of a spur, its termination dilated, ascending, spreading, either undivided or lobed. Stam. Anther an hemispherical, deciduous, terminal lid, of two or four cells; masses of pollen stalked, in pairs. Pist. Germen inferior, oblong or obovate, erect, furrowed; style semi-cylindrical, often gibbous, concave in front; stigma either concave or convex, in the fore-part of the style near the top. Peric. Capsule oblong or obovate, with three or six ribs, with one cell and three valves, opening by clefts between the ribs. Seeds numerous, minute, each clothed with a chaffy tunic, inserted into the downy internal ridges of the valves.

Eff. Ch. reformed. Calyx-leaves spreading. Lip tubular at the base, attached to the fore-part of the style, destitute of a spur. Anther a terminal lid, deciduous.

The original genus of *Epidendrum* in Linnæus, whose essential character is "Nectary turbinate, oblique, reflexed," comprehends many species which do not answer to that character, and which have, indeed, in several instances, been referred to this genus without a sufficient knowledge of their flowers. Hence professor Swartz has chiefly derived his genera of *Cymbidium*, *Dendrobium*, (see those articles,) *Oncidium*, *Aërides*, and *Vanilla*, so that his *Epidendrum*, whose characters we have given above, is become a much smaller, as well as a more intelligible genus, though perhaps not more natural, it having the closest possible affinity to *Cymbidium* and *Dendrobium*. The species in Swartz are 23, in Willdenow 26. Professor Martyn has, with great industry, collected 124 under the original genus. Dr. Swartz mentions 19 new ones as discovered in South America by the authors of the Flora Peruviana and Chilensis.

Among the genuine species of *Epidendrum*, as the genus stands at present, are

*E. cochleatum*, Linn. Sp. Pl. 1351. Curt. Mag. t. 572. Jacq. Ic. Rar. t. 605. Andr. Repof. t. 13. A native of Jamaica, and the first of its tribe that ever flowered in England. It is cultivated in a stove, in rotten bark, contrived so as to imitate, as much as possible, its natural situation in the clefts of aged trees, with occasional supplies of water. The bulbs are green and smooth, of a compressed oval figure, each throwing out from its base numerous thick entangled fibres, which naturally adhering to the rugged bark, strongly fix the plant and imbibe nourishment for its support. A pair of oblong, rigid, recurved leaves, entire, as in all this natural order, spring from the summit of each bulb, and between them grows a stalk, about a foot high, bearing a spike of several flowers. These are reversed, the long pale-greenish calyx and petals hanging down, while the broad, concave, somewhat cordate nectary, of a chocolate hue speckled with green, stands erect. The flower has little or no smell.

*E. fragrans*. Sw. Prod. 123. (*E. cochleatum*; Curt. Mag. t. 152.) A native also of Jamaica, flowered in the stove of Chelsea garden, under Mr. Fairbairn's care, in Feb. 1789. This has much resemblance to the foregoing, but the petals are broader, the nectary pale streaked with red, and tipped with a long point, and the flowers have a sweet smell. The stalk moreover is shorter in this species than the leaves.

*E. amabile*. Linn. Sp. Pl. 1351. (*Angræcum album majus*; Rumph. Amb. lib. xi. 99. t. 43.) Native of the East Indies. This has beautiful white blossoms, twice as large as in Rumphius's plate, on a long slender branched stalk. The lip is five-lobed, and terminates besides in a pair of very long, taper, almost capillary points. It would be a great acquisition to our stoves.

*E. nutans*. Sw. Prod. 121. A native of Jamaica, flowered in Kew gardens in March 1791. This has a leafy stem, terminated by a stalk bearing a few pale flowers, whole lip is four-lobed. They are about the size of *E. fragrans*.

*E. ciliare*. Linn. Sp. Pl. 1349. Curt. Mag. t. 463. is a beautiful and magnificent plant, native of the West Indies, which flowered at Mr. Whitley's nursery, Old Brompton, for several years before 1799. (*Curtis*.) The flowers are numerous and fragrant; their calyx-leaves and petals each near two inches long, of a yellowish buff-colour; lip white, with two elegantly fringed lobes. This species is now not very rare in the English stoves.

*E. fuscatum*. Sm. Spicil. t. 23. is rather singular than ornamental. The late Hon. Mrs. Barrington received it from Jamaica, and it blossomed in her garden in 1791. The stem is leafy, and terminates in a very long simple scaly stalk, bearing a dense corymbus of small flowers, which, like the whole plant, are of a brown purplish hue.

Several species, more or less a-kin to this last, occur in the works of Jacquin, as well as some more splendid ones with tall branching stalks, none of them yet introduced into our gardens.

**EPIDERMIS**, in *Anatomy*, is the thin insensible membrane which covers the true skin, and which constitutes, therefore, in all parts, the external surface of the body. See **SKIN**.

**EPIDERMIS**, in *Vegetable Anatomy*, from *επι*, upon, and *δερμα*, the skin, or hide, is the scarf skin, or pellicle, which covers every part of a living plant, as a similar cuticle covers the human skin. In the tender growing parts of vegetables this membrane is of the most delicate texture, pellucid and colourless, extremely thin, yet not destitute of tenacity, being wonderfully extensible on stalks, or other parts, of quick growth. Under a high magnifier it is found to be porous in a regular manner, and differently in different plants, so as to allow of the passage of fluids in a definite degree, in either direction, according to the nature of each plant. Hence some leaves perspire slowly, but imbibe moisture with great rapidity, as those of the succulent tribes; while others transmit their fluids, or imbibe external moisture, with nearly equal facility, as aquatics. Such differences are detected by experience, but scarcely discoverable by microscopical investigation.

The *Epidermis* is of the most essential importance to the life of the plant, as of the animal, protecting the living parts which it covers from the injuries of the air, while it allows of due perspiration and absorption, as well as of the action of light through its nearly colourless substance. It differs greatly in thickness according to the part of the plant to which it belongs. Exquisitely delicate on the fine organs of a flower, like the cuticle of the animal eye, it has considerably more substance on the leaf, and still more on the

branch of a tree. On old trunks it is generally obliterated or destroyed, being there no longer necessary, the dead layers of bark, (see BARK and CORTEX,) answering all the purposes of protection, while the peculiar functions of an organized porous *epidermis* are not wanted. Yet in the birch, and a few other trees, the membrane in question consists of multiplied permanent layers, like the bark, and clothes the trunk as long as that part exists. The cuticle is easily separable from young stalks in a rapid state of vegetation, and from any part of a plant by means of maceration, boiling or putrefaction, being nearly, if not absolutely, destitute of vitality, and very little subject to decomposition.

Besides the essential office of a guard to the living vegetable body against all hurtful stimulants, the *epidermis* answers many secondary purposes of protection: When naked, as usual, it proves but a feeble defence against heat or cold, but it is often covered with hair or wool, in which case it becomes a very powerful one, particularly against the too violent action of a burning sun. Flowers indeed, though peculiarly presented to all the force of this luminary, have scarcely ever any such woolly or downy defence; for the functions which they have to perform are often urgent with respect to light and heat. Many petals, notwithstanding, are silky or downy on their outside, apparently to protect them from cold, or possibly from too scorching a heat before they are full-grown, examples of which may be seen in *Convolvulus*, *Anemone*, and several other genera; but the insides of such petals are exquisitely smooth.

Examples of a very firm smooth *epidermis*, of considerable strength and thickness, may be found in the common currant, *Ribes rubrum*, the elder, *Sambucus nigra*, and the laburnum, *Cytisus Laburnum*. On the branches of the latter it acquires almost a horny hardness; but it is still more cartilaginous in the hard white tubercles sprinkled over the leaves of *Aloe perlata*, and in the teeth of the foliage of some *Saxifrage*, as well as the brittle warts of several species of *Echium* and others of the *asperifolia*. On the leaf of the white willow, and the *Protea argentea*, the cuticle has a fine silky clothing of a silvery hue; while in many more plants it is equally white, but destitute of gloss. In the leaf of many kinds of mullein, *Verbascum*, and the fruit of the peach, we find it densely covered with hairs, more or less branched. The herbage of the betony, *Betonica officinalis*, is clothed with rigid bristles, fixed upon the cuticle, which in a dry state excite sneezing. Similar hairs on the cuticle of the stinging nettle are curiously perforated, to transmit a venomous fluid lodged in bags at their base, like the poison in a serpent's tooth. Grasses, corn and horsetail, *Equisetum*, have much stony earth in their *epidermis*; while in the cork-tree, the common maple, and the Dutch elm, the same part is of a soft elastic fungous substance. The fruit of the plum, and leaves of the cabbage, have their *epidermis* covered with a fine blueish powdery resinous secretion, which will scarcely allow rain to come in contact with them, yet such plants readily absorb moisture.

Nothing can be more absurd than the idea which some philosophers have formerly entertained, that the *epidermis* was destined to give shape to a plant, and that certain lumps or excrescences on the stems of trees were originally owing to a casual wound or crack in this membrane. This opinion is easily refuted by purposely making such a wound or opening, when it will be found that no tumour can be produced by any such means; spontaneous tumours being in reality the cause, not the effect, of the bursting of the *epidermis*. S.

EPIDICASIA, *Επιδικασία*, among the Athenians. Daughters, inheriting their parents' estate, were obliged to marry their nearest relations; which gave occasion to

persons of the same family to go to law with one another, each pretending to be more nearly allied to the heirs than the rest. The suit was called *επιδικασιας δικη*; and the virgin, about whom the relations contended, *επιδικος*. Pott. Archæol. Græc. lib. 1. cap. 24. tom. i. p. 147.

EPIDIDIUM, in *Ancient Geography*, is the name which Ptolemy gave to that peninsula on the western coast of Scotland, which forms part of the county of Argyll, called Cantyre and Knapdale; and including the isles of Islay and Jura, which the Roman geographer considered as being part of it: but whether it then was integral, or not, cannot be ascertained from his account. The peninsula might at an early period have been an island; such changes has the sea made upon our surge-beat coasts: for "Dr. Smith derives this name from a similar Celtic word, signifying the isle of the Picts, who at that time were the principal inhabitants of that part of Scotland." Sir John Sinclair's Stat. Acc. vol. x. p. 519. But such a conclusion is not justifiable by the rules of Celtic derivation. *Cyn*, in that language, signifies a wedge, and *tor*, land or territory; it is, therefore, obviously derived from those two etymons conjoined, perfectly descriptive of such a tongue of land, *i. e.* a wedge-shaped territory. Mr. Baxter imagines the Pepidii, synonymous with Epidii, to have derived their name from the British word Papidiauc, which signifies any thing shaped like a flute or pipe, as was the peninsula of Cantyre, the country of the Pepidii. From the southern point, called the mull of Cantyre, promontorium Epidium, the coast of Ireland may be plainly seen; it being only 16 miles to the south foreland in Coleraine.

EPIDIDYMIS, in *Anatomy*, a part of the testicle, situated behind the body of that organ, and consisting of its excretory duct in a wonderfully convoluted form. It ends in a straight tube, called the vas deferens. See TESTIS.

EPIDO'SIS, from *επιιδωμι*, to increase, in *Surgery*, a preternatural enlargement of parts.

EPIDOT. See STRAHLSTEIN.

EPIDOTES, from *επιιδωμι*, I cause to grow, in *Mythology*, deities which were supposed to preside over the growth of infants.

EPIDROME, from *επι*, upon, and *δρομη*, to run, in *Surgery*, an afflux of fluids, or, as they were formerly phrased, humours, especially when it arose from the application of a ligature round any part.

EPIDROMUS, of *επι* and *δρομη*, course, in the *Ancient Shipping*, a sail near the stern, which was the largest but one in the ship.

EPIECIA, in *Ancient Geography*, a town of Greece, towards the sea, and not far from Corinth; N. of Tenæa.

EPIEZ, in *Geography*, a town of France, in the department of the Loiret, and district of Beaugency; 12 miles E. of Orleans.

EPIGÆA, in *Botany*, from *επι*, upon, and *γαια*, the earth, expressive of the prostrate growth of this humble shrub. Linn. Gen. 219. Schreb. 295. Willd. Sp. Pl. v. 2. 615. Mart. Mill. Dict. v. 2. Juss. 161. Clafs and order, *Decandria Monogynia*. Nat. Ord. *Bicornes*, Linn. *Erica*, Juss.

Gen. Ch. *Cal.* Perianths double, close together, permanent; the outer of three ovato-lanceolate, pointed leaves, of which the external one is larger than the rest; inner in five deep, upright, lanceolate, pointed segments, somewhat longer than the outer. *Cor.* of one petal, salver-shaped; tube rather longer than the calyx, hairy within; limb spreading, in five deep ovate-oblong lobes. *Stam.* Filaments ten, thread-shaped, the length of the tube, and inserted into its base; anthers oblong, acute. *Pist.* Germen globose,

globose, with five furrows, downy; style cylindrical, as long as the stamens; stigma obtuse, in five lobes. *Peric.* Capsule nearly globular, depressed, with five angles, five cells, and five valves. *Seeds* numerous, roundish. *Receptacle* large, separating into five parts.

*Ess. Ch.* Outer calyx of three leaves; inner in five deep segments. Corolla salver-shaped. Capsule of five cells, with a central five-parted receptacle bearing the seeds.

The species are two.

1. *E. repens.* Linn. Sp. Pl. 565. Swartz Prod. 74. Andr. Repof. t. 102. Lamarck Illustr. t. 367. f. 1. "Leaves ovate, inclining to heart-shaped, entire. Tube of the corolla cylindrical." Native of pine forests in Virginia and Canada, but, like many plants of a cold or alpine climate, difficult to preserve in our gardens. It flowers in April or May. The root throws out many woody, procumbent, creeping, branched, hairy, leafy stems, which form wide-spreading patches. Leaves alternate, on hairy foot-stalks, ovate, obtuse, entire, heart-shaped at the base, veiny, shining, but roughish to the touch. *Stipulas* none. *Flowers* in terminal, dense, bracted clusters, fragrant, of a pale blush-colour, each about the size of a small cowslip. It is increased by parting the roots, thrives in a light sandy loam, but requires the shelter of a long-continued deep snow, or some equivalent protection, to survive our winters. We saw it in great perfection at Messis. Lee and Kennedy's nursery, Hammer-smith, in 1797.

2. *E. cordifolia.* Swartz Prod. 73. Lamarck Illustr. t. 367. f. 2. "Leaves heart-shaped, roundish, serrated, convex, hispid, rigid. Tube of the corolla ovate." Native of boggy places on the highest mountains of Guadeloupe and Cayenne. Smaller than the former, with pointed and more hispid leaves, whose foot-stalks are very short. *Flowers* in like manner terminal, but with a more inflated tube. The young shoots are very hairy.

**EPIGÆA**, in *Gardening*, comprehends a plant of the low, trailing, shrubby, flowering kind. This is the creeping epigæa, or trailing arbutus (*E. repens*).

*Method of Culture.*—This is readily effected in this plant by the trailing stalks, which soon put out roots at the joints, and may then be cut off from the old or parent plants, and be set out in a shady situation, where the soil is moist, in the autumnal season, that the plants may be well established before the spring. In cases where the winter proves severe, it may be necessary to lay a few dried leaves, or other light covering over them, to protect them from frost; but after they become well rooted, they seldom require more than being kept clean from weeds.

These are ornamental plants in the fronts of the borders of shrubberies.

**EPIGASTRIC ARTERY**, in *Surgery*. The proper mode of operating in certain cases of ruptures, so as not to run any risk of wounding this vessel, will be explained in the article **HERNIA**.

**EPIGASTRIC REGION**, in *Anatomy*, one of those portions, into which the cavity of the abdomen is divided by anatomists in their descriptions. "The epigastric region," says Winflow, "begins immediately under the appendix ensiformis at a small superficial depression, called the pit of the stomach, and in adult subjects ends above the navel at a transverse line, supposed to be drawn between the last false ribs on each side.

"This region is subdivided into three parts, one middle, named epigastrium, and two lateral, termed hypochondria. The epigastrium takes in all that space which lies between the false ribs of both sides, and the hypochondria are the spaces covered by the false ribs." Sect. 7. § 79, and 80.

**EPIGASTRIUM.** See **EPIGASTRIC**.

**EPIGINOMENA**, of *επιγινόμενα*, *I supervene*, in *Medicine*, are new symptoms which occur in the progress of a disease. See **EPIPHENOMENA**.

**EPIGLOTTIS**, in *Anatomy*, is a small and thin piece of cartilage, placed at the back of the tongue, and having the office of closing the glottis, or opening of communication between the larynx and pharynx, when the food is passing into the latter cavity from the mouth. The anatomical description of this part will be found in the article **LARYNX**; its offices are described in that of **DEGLUTITION**.

**EPIGONIUM**, *επιγονιον*, a musical instrument among the ancients, with forty strings, so called from its inventor Epigonius, a native of Ambracia, a city of Epirus. Mem. Acad. Inscript. vol. v. p. 167.

**EPIGONIUS**, in *Biography*, was a mathematician of Sicyon, and a native of Ambracia, who is celebrated by the ancients for the invention of an instrument of forty strings, which was called after his name, Epigonium. When he lived is uncertain, but as it was in times of simplicity, we may suppose that these strings did not form a scale of forty different sounds, but that they were either tuned in unisons and octaves to each other, or accommodated to different modes and genera. The 12 semi-tones of our three-stopt harpsichords included thirty-six different strings.

The Greeks were divided into numerous sects of musical speculators, before and after the time of Aristoxenus: as the Epigonians, Damonians, Eratoclians, Agenorians, and many others enumerated by Porphyry, in his Commentary on the Harmonics of Ptolemy. Of these, however, all we know is, that they differed; it is, perhaps, little to be lamented, that we no longer know about what.

Music has many obligations to Epigonius. He was the first who played on stringed instruments without a *plestrum*. And, according to Athenæus, he first united the melody of flutes to that of the citharas; and by this means softened the harshness and inflexibility of the citharas when played alone. He invented the chromatic genus, and was the original author of choruses.

**EPIGRAM**, in *Poetry*, a short poem, or composition in verse, treating only of one thing, and ending with some point, or lively ingenious thought.

The word is formed of *επιγραμματα*, *inscription*, of *επιγραψω*, *to inscribe*, or *write upon*.

Epigrams then, originally, signify *inscriptions*, and they derive their origin from those inscriptions placed by the ancients on their tombs, statues, temples, triumphal arches, &c. See **INSCRIPTION**.

These, at first, were only simple monograms: afterwards increasing their length, they made them in verse, to be the more easily retained: Herodotus, and others, have transmitted to us several of them.

Such little poems retained the name of epigrams, even after the design of their first institution was varied, and people began to use them for the relation of little facts and accidents, the characterising of persons, &c.

The Greeks confine their epigrams to a very narrow compass; for though, in the Anthology, we here and there meet with a very long one; yet, ordinarily, they do not exceed six, or, at most, eight verses. The Latins were not always so scrupulous, and the moderns much less, as to these bounds.

M. le Brun, in the preface to his "Epigrams," defines an epigram a little poem, susceptible of all kinds of subjects, and ending with a lively, just, and unexpected thought; which are three qualifications essential to the epigram; particularly

ticularly the first and last of them, *viz.* brevity, and the point or close of the epigram.

To attain brevity, only one thing is to be aimed at in the poem, and that to be pursued in the concise terms possible. Authors are much divided as to the length the epigram is to be confined to; the ordinary limits are from two to twenty verses; though we have instances, both among the ancients and moderns, where they extend to fifty. But still it is allowed, that the shorter the better, and more perfect, as it partakes more of the nature and character of this kind of poem. The point or turn is a quality much insisted on by the critics, who require the epigram constantly to close with something poignant and unexpected, to which all the rest of the composition is only preparatory. Others there are, who exclude the point, and require the thought to be equally diffused throughout the whole poem, without laying the whole stress on the close: the former is usually Martial's practice, and the latter that of Catullus. Which is the most beautiful and perfect manner is disputed by a third class of critics.

The Greek epigrams have scarce any thing of the point or briskness of the Latin ones: those collected in the Anthology have most of them a remarkable air of ease and simplicity, attended with something just and witty; such as we find in a sensible peasant, or a child that has wit. They have nothing that bites, but something that tickles. Though they want the salt of Martial, yet, to a good taste, they are not insipid; except a few of them, which are quite flat and spiritless. However, the general faintness, and delicacy of the pleasantry in them, has given occasion for a Greek epigram, or "epigram à la Greque," to denote, among the French, an epigram void of salt or sharpness.

It is principally the point that characterizes the epigram, and distinguishes it from the madrigal. See POINT.

In the modern versification, as observed by F. Mourgues, the epigram and madrigal are distinguished by the number of verses and the close. 1. By the number of verses, which in the modern epigram does not go beyond eight, nor in the modern madrigal comes short of six; and, 2. In that the close, or period, of the epigram, has always something more lively and studied than that of the madrigal.

The epigram is the lowest, and least considerable of all the productions of poetry; and it is in general rather an effect of good luck, than of art, to succeed therein. The finesse, and subtilty, of the epigram, M. Boileau observes, should turn on the words rather than the thought; which seems very little to the credit of this kind of composition, as it reduces it to the nature of the pun, or equivoque. F. Bouhours confirms the hint, in adding that the equivoque is what usually shines the most in the epigram.

One great beauty of the epigram is, to leave something for the reader to guess, or supply. Nothing pleases the mind so much, as to find something in itself in the objects presented it; nor does any thing disgust it more than to preclude it from shewing and exercising a faculty it values itself for. Segrais.

The epigram admits of great variety of subjects: some are made to praise, and others to satirize, which last are much the easiest; ill-nature serving instead of point and wit. Boileau's epigrams are all satires on one or another. Those of Des Reaux are all made in honour of his friends; and those of Mad. Scudery are so many eulogues. The epigram being only a single thought, it would be ridiculous to express it in a greater number of verses; it must have its unity

like the drama. The comedy has an action for its subject, and the epigram a thought.

We might select a number of excellent epigrams in our own language, if our limits allowed of enlarging this article. We shall content ourselves with subjoining the following. The first is that of Mr. Pope, said to be written on a glass with the earl of Chesterfield's diamond pencil.

"Accept a miracle, instead of wit,  
See two dull lines by Stanhope's pencil writ."

The next is an epigram, expressed concisely and closing beautifully, which was written on the leaves of a fan by Dr. Atterbury, late bishop of Rochester:

"Flavia the least and slightest toy  
Can with resistless art employ.  
This fan in meaner hands would prove  
An engine of small force in love;  
Yet she with graceful air and mien,  
Not to be told or safely seen,  
Directs its wanton motion so,  
That it wounds more than Cupid's bow.  
Gives coolness to the matchless dame,  
To every other breast a flame."

Mr. Prior lashed the impertinence of a bad writer, who had taken the liberty of censuring him, in the following epigram:

"While faster than his costly brain indites,  
Philo's quick hand in flowing letters writes.  
His case appears to me like honest Teague's,  
When he was run away with by his legs:  
Phoclus, give Philo o'er himself command;  
Quicken his senses, or refrain his hand.  
Let him be kept from paper, pen, and ink,  
So he may cease to write, and learn to think."

The following epigram was written by Mr. Wesley, on occasion of erecting a monument to Mr. Butler, author of Hudibras, in Westminster Abbey:

"While Butler, needy wretch, was yet alive,  
No generous patron, would a dinner give.  
See him, when starv'd to death, and turn'd to dust,  
Presented with a monumental bust!  
The poet's fate is here in emblem shown,  
He ask'd for bread, and he receiv'd a *stone*."  
See BUTLER.

EPIGRAPHE, *Ἐπιγραφή*, *Superscription*, an inscription on a building, to signify its use, occasion, the time when, and the person by whom it was built.

EPIGRAPHERS, *Ἐπιγραφεύς*, among the Athenians, officers that rated all those of whom taxes and contributions were required, according to every man's ability, kept the public accounts, and prosecuted such as were behind-hand with their contributions. Potter. Archæol. Græc. lib. i. cap. 14. tom. i. p. 81.

EPILA, in *Geography*, a town of Spain, in the province of Arragon, on the Xiloca; 17 miles W. of Saragossa.

EPILEPSY, in *Medicine*, *ἑπιληψία*, and *ἑπιληψίς*, signifying *sudden seizure*, is a disease which consists of convulsions of the greater part of the muscles of voluntary motion, attended with a loss of sense and feeling, and ending in a state of insensibility, and seeming sleep.

This disease has received a variety of denominations, especially among the ancient writers. By the early Greeks it was called the  *sacred disease*, from a notion of its origin in supernatural

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supernatural influence; some of the exorcists and impostors of those times even pretended to decide, from variations in the symptoms, whether the fits were occasioned by Cybele, Neptune, Mars, or some of the heroes. Hippocrates seems to have been the first who combated these absurd notions of his countrymen; and severely reprehends the impostures of the exorcists, in pretending to set aside what more than human power had inflicted, by incantations, magic ceremonies, and sometimes by the most contemptible juggling. (See Hippoc. de *Morbo Sacro*.) Aretæus, however, remarks that it might have the denomination of *sacred* on other accounts; either from its magnitude, every thing great being deemed sacred; or because it could not be removed by human means, but only by divine power; or from the opinion that a *dæmon* had entered into the patient, or for all these reasons together. (De *Causis Affect.* lib. i. See also Cæl. Aurelian. De *Morb. Chron.* lib. i. cap. iv.) In like manner the Romans call every thing remarkable and great "sacred:" "*sacra anchora*," "*aurei sacra fames*," &c. (Van Swieten. § 1071.) Upon the same ground epilepsy has been called *morbus Herculeus*, the Herculean disease. By the Romans, it was sometimes termed *morbus comitalis*, "the assembly disease;" either because epileptic persons were more frequently observed to be seized in a crowd of people, or because the public meetings, called *comitia*, were adjourned if any one happened to be attacked with an epileptic fit. It has likewise been termed *morbus caducus*, or "falling sickness," because the patients, when they are seized with the paroxysm, fall down.

The leading features and principal circumstances of the epileptic convulsions are nearly the same in all the different persons whom the disease affects. The disease consists of fits, which attack suddenly often those who are seemingly in perfect health, and, after lasting for some time, pass off, and leave the persons again in their usual state.

The individual attacked loses suddenly all sense and power of directing his muscular actions; so that, if standing or sitting, he falls immediately, or perhaps with convulsions is thrown to the ground. In that situation he is agitated with violent convulsive actions, variously moving his limbs and the trunk of his body, with a force that is altogether preternatural. Commonly the limbs on one side of the body are more violently agitated than those upon the other. In all cases the muscles of the face and eyes are much affected, exhibiting various and violent distortions of the countenance. The tongue is often affected, and thrust out of the mouth, while the muscles of the lower jaw are also affected, and, shutting the mouth with violence, often wound the tongue grievously. While these convulsions continue, the face becomes red, then livid and swelled, from the interruption to the circulation through the head, and there is commonly at the same time a frothy moisture issuing from the mouth; and in the most severe cases the urine and alvine excrements are involuntarily discharged. In some instances a hissing or stertorous noise is emitted. The convulsions have for a few moments some remissions, but are suddenly again renewed with great violence. Generally, after no long time, this terrible struggle ceases altogether, and the patient remains for some time without motion, in a state of absolute insensibility, and under the appearance of a profound sleep. After some continuance of this seeming sleep, he sometimes suddenly, but for the most part by degrees only, recovers his senses and power of motion, but without any memory of what had passed from the first seizure of the fit, and complaining of head-ache, and excessive pain in all the limbs as if from severe fatigue. During the convulsions the pulse and respiration are hurried and irre-

gular; but, when the convulsions cease, they return to their usual regularity and healthy state.

In most cases the attack of epilepsy comes on suddenly, without any warning symptom: but sometimes it is preceded by certain sensations for a few moments previous to its actual commencement. Of these the most remarkable is that, which has been termed the *Aura epileptica*; which is a sensation of something moving in some part of the limbs or trunk of the body, and from thence creeping upwards to the head; and when it arrives there, the person is immediately deprived of sense, and falls into an epileptic fit. This feeling is described sometimes as resembling that of a cold vapour, sometimes as like a fluid gliding, and sometimes like the sensation of a small insect creeping along the body; and very often the patients can give no other distinct idea of their sensation, than as in general of something moving along. It might be supposed that this sensation arose from some affection of the extremity or other part of a nerve, acted upon by some irritating cause; and that the sensation, therefore, followed the course of such a nerve. But it is not found to follow the course of any nerve distinctly, and it generally seems to pass along the integuments. There are occasionally also other symptoms immediately preceding the fit, and generally referred to the head, where no *aura* is perceived. In some persons a giddiness comes on; in others a spark of light, which increased to a bright beam, usually ushers in the paroxysm; depending probably on the sudden turgescence of the vessels in the head, which produces pressure on the optic nerve, and occasions this depraved sensation. Dr. Gregory used to mention in his lectures, at the college of Edinburgh, the case of an officer, who had a more singular perversion of sight, previous to the fit of epilepsy; he always fancied that he saw an apparition of an old woman, with a blue cloak, holding a staff in her hand, with which she knocked him down. He also mentioned an instance of visual deprivation which occurred to Dr. Fothergill; a young lady, whom the Dr. was attending as an epileptic patient, remarked that he was covered with spangles, (the more unusual as an ornament to a quaker's coat,) and immediately she fell down in a fit.

Under the article *CONVULSIONS* we have entered into a detail of the circumstances which conduce to their origin and production; and as the whole of those observations apply to the epileptic convulsions most particularly, it will not be here necessary to repeat them. We have there stated that convulsions occur under two opposite conditions of the body, *viz.* of *repletion* and *inanition*; or, in the language of Dr. Cullen, of *excitement* and *collapse* (First Lines, § 1286.): and that various *irritations* in different parts of the body, but especially in the head, give rise to them in different instances.

Sauvages has described a great variety of species of epilepsy, which he has distinguished chiefly according to the causes which produced them. Dr. Cullen has mentioned only three species, which (as to the utility of division with a view to the curative indications) might be reduced to two. His first species is *epilepsia cerebialis* (from *cerebrum*, the brain), which attacks suddenly, without any evident cause, or preceding sensation, except perhaps a giddiness or deprivation of sight; and includes the *plethoric* epilepsy and *eclampsia* of Sauvages, as well as his *cachectic* epilepsy. The second species, is *E. sympathica*, in which the *aura epileptica*, before described, precedes the attack; a circumstance which is scarcely of sufficient importance to designate a species. The third, *E. occasionalis*, includes those instances of epilepsy which originate from manifest and accidental irritation, and which subside when the irri-

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tation is removed. These various causes of irritation are, wounds, or blows of the head, from falls, and other external injuries; pain in various degrees, as from parturition, dentition, worms in the alimentary canal; indigested food, or other substances in the stomach, as narcotic poisons, spirituous liquors, &c; passions of the mind, especially fear; and a variety of other sources of disturbance to the system, as the eruption of small-pox, and other febrile irritations, the venereal orgasm, intense study, the suppression of customary discharges, &c.; and, lastly, the imitative propensity, which is particularly conspicuous in women and children, as illustrated at large under the head of CONVULSIONS.

We have there stated the impossibility of explaining the proximate cause of convulsive diseases, in consequence of our ignorance of the nature of the nervous power, or of the connection between the action of the muscles and the brain, or the faculty of volition, in a state of health. And it were sufficient to mention the attempts to reason upon the subject, which the ablest physicians have made, in order to prove their futility. The learned Boerhaave says, (*Aph.* 1086.) "Et patet quidem, causam proximam omnium epilepsiarum exquisitam esse nimiam cerebri in nervos motorios, nullam in sentientes, actionem." "It is obvious that the proximate cause of every perfect epilepsy is always too great an action of the brain upon the nerves of motion, and too little upon those of sense:" which is only stating the fact in other words; for it amounts merely to this: "in every true epilepsy the motions of the body are violent, and the sense is lost: the proximate cause is still as obscure as before." Dr. Cullen scarcely pretends to form a theory upon the subject. "I might say," he observes, "that it is an affection of the energy of the brain, which, ordinarily under the direction of the will, is here, without any concurrence of it, impelled by preternatural causes. But I could go no further: for as to what is the mechanical condition of the brain, in the ordinary exertions of the will, I have no distinct knowledge; and therefore must be also ignorant of the preternatural state of the same energy of the brain under the irregular motions here produced." (*First Lines*, § 1284.) The indications of cure therefore cannot be formed from a knowledge of the proximate cause of the disease; but we obtain some useful intimations for the treatment, by diligently attending to the various remote causes; both those which induce a predisposition, and those which occasionally excite the disease. Our principal object, then, will be to avoid the occasional causes, and to remove or correct the predisponent.

The predisposition to epilepsy, in the majority of instances, seems to consist partly in what may be termed a morbid irritability, or mobility, of constitution, in which the action of slight irritations (which are applied to most persons with impunity) excites great commotion in the nervous system; and partly in a turgescence of the vessels of the head, which accompanies a general plethora. This appears from the circumstances, that plethoric persons are very frequently the subjects of epilepsy; that it is often brought on by causes inducing any unusual turgescence of the blood-vessels; and that it has been frequently cured by diminishing the plethoric state of the body, more frequently, we believe, than by any other system of practice. This principle was inculcated by Dr. Cullen, and is strenuously adopted by the present Dr. Gregory, his successor. It was likewise maintained by the late Dr. Fothergill, who has left us the following excellent remarks on this point of practice.

After stating that many epilepsies occurred to him, which eluded all his endeavours to relieve them by means of the medicines ordinarily recommended as specifics, and which

therefore suggested the necessity of adopting some other mode of procedure, he says, "I had observed that fits were most liable to return in the plenitude of health; that epileptics were often extremely incautious in respect to diet; that children, highly indulged, were liable to the disease; that in every other period of juvenescence, and in middle aged adults, if they were at all subject to the disease, it was when they had either committed some excesses, or, by one means or another, were plethoric; and that, in habits subject to epilepsy, the disease seldom recurred, without either an habitual indulgence in eating, or a neglect of necessary exercise. This induced me to recommend, in many cases, a total abstinence from all animal food, and from all fermented liquors. Care was taken to regulate the secretions, and such a course of medicine prescribed, as might seem expedient to induce the patients, or their friends, scrupulously to comply with such a course of diet. It was in vain to restrict the quantity of animal food. There are few who have, at all times, resolution enough to submit to the first intimations of satiety. It was, therefore, necessary to enjoin such a kind of diet, as was accompanied with but slender provocations to excess, and which, at the same time, would afford the least quantity of nutriment; by which that fullness, which, in many epileptic cases, appears to be a stimulus sufficient to produce the spasms, would be avoided, and the parts, which were the immediate seat of irritation, might gradually recover a degree of strength and firmness, that would be proof against every slight impression.

"It often happens in diseases, that a proper plan of diet is of much more importance in the cure than any thing we are acquainted with in the *Materia Medica*: it is, however, of not less necessity to engage the patients and their friends in a steady perseverance of the method we direct. The generality of people have very little notion that diet can do more than merely support their strength; that it can be made subservient to the cure of their diseases, they cannot easily be brought to comprehend, &c.

"In young boys, I apprehend, the epilepsy most generally proceeds from their own craving appetites, and the neglect of those who are about them. It may not be improbable, but in such cases worms may also have a share in producing the fits. Be this as it may, anthelmintics, however powerful, seldom cure the disease; they may abate occasionally the frequency, or the violence of the attacks, but they too often, at the same time, bring on a greater degree of irritability, and at length, if repeated frequently, and in considerable doses, seldom fail of confirming the disease. Moderate laxatives, with a light chalybeate interposed, and steadily continued, with a course of diet, consisting of milk, vegetables, fruit, and things prepared from them, and in moderate quantities, seldom fail of removing the disease in such habits. Riding and bathing in cold water, and the usual means of establishing good health, must, at the same time, be attended to, and the plan pursued with patience; for it is not to be expected in diseases that affect the nervous system, the most remote and finest part of the economy, when once they have debilitated, or otherwise disordered, these very feeling parts, and their influence is become habitual, that after-medicines, however active, penetrating, and efficacious, can, in a very short time, restore the ability to perform their functions as they ought to do." (See *Medical Obs. and Inquiries*, vol. vi. p. 72.)

This plan of light and moderate living, with occasional laxatives, should be adopted in every case of epilepsy, where it does not arise from loss of blood, or other causes of inanition, or is not connected with a cachectic or emaciated habit: and even in the last case, the plan is often useful, especially

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cially where a morbid change, such as exostosis, suppuration, or tumour of any kind, is going on in the head.

It might be supposed that artificial evacuations, especially blood-letting, would be the most effectual means of diminishing the plethoric state of the system: and such it certainly proves, when the plethora has become considerable; and if it threatens immediate disease, this evacuation ought to be made to the quantity that the urgency of the symptoms seems to require. It is, however, a matter of old observation, that blood-letting is not the proper mode of preventing the recurrence of the plethoric state; but, on the contrary, that it is often the means of favouring it, especially when the operation is performed at regular periods. There is, however, a case of epilepsy, as Dr. Cullen remarks, in which there is a periodical or occasional recurrence of the fullness and turgescence of the sanguiferous system, giving occasion to a recurrence of the disease. In such cases, when the means of preventing plethora have been neglected, or may have proved ineffectual, it is absolutely necessary for the practitioner to watch the returns of these turgescences, and to obviate their effects by the only certain means of doing it, that is, by a large blood-letting. When the general plethora is not great, but the symptoms indicate considerable local turgescence in the head, the application of cupping-glasses, after scarification of the neck, or the use of a seton, blister, or issue, near the same part, will afford the means of some relief, by the evacuations which they produce. An open issue, indeed, in distant parts, as in the arm, has been found useful in some instances of epilepsy, by tending to obviate the plethoric state, or, as Dr. Cullen suggests, by determining occasional turgescences to those parts, and, therefore, diverting them, in some measure, from their action upon the brain.

Epilepsy, however, as we have already stated, is also the result of a state of debility, with which the excessive nervous mobility that is easily excited to convulsions is, in many other instances, observed to be connected; especially in hysteria, in the condition of infancy, &c. Where this debility has been the consequence of inanition, as from loss of blood, from previous disease, and so forth, a nourishing generous diet will be requisite to restore the strength; and instances are occasionally seen, in which the propriety and success of this practice are manifest. Where there is obviously a feeble state of body, with pale complexion, and without any appearances of local plethora, the propriety of being much in the open air, of using the cold bath frequently, and of regular exercise, adapted to the strength and habits of the patient, must be equally evident. He may still farther contribute to remove debility, and its consequences, especially that great mobility which is a principal part of the predisposition to epilepsy, by the use of tonic and antispasmodic medicines.

By a sort of routine, too generally pursued by indiscriminating practitioners, remedies of the last mentioned classes are most commonly given in epileptic cases, more particularly of late the metallic tonics, while the diet and regimen are not sufficiently attended to. However, as the circumstances of the constitution occasionally favour their operation, it cannot be doubted that the disease has, in many instances, been removed by these means; and numerous cases are on record, in which particular species of tonic remedies have effected the cure of epilepsy. The preparations of iron have been most commonly employed for this purpose, as the rubigo ferri, or the sulphat of iron, or its combination with ammonia (ferrum ammoniacale); and cures have been said to be accomplished by all these preparations. Dr. Cullen, however, observes, that he never found them effectual;

which he attributes partly to their not having been always employed in the proper circumstances of the disease, and partly to the inadequate quantities in which they have been given. (First Lines, § 1335.) A preparation of copper, the cuprum ammoniacum of the Edinburgh Dispensatory, has been one of the most celebrated of the metallic tonics, and Dr. Cullen admits it to have been often successful. It should be given in the dose of one grain at first, twice in the day, and gradually increased to as much as the stomach will bear. Zinc, especially in the form of flowers of zinc, (as the oxide was formerly denominated,) has been much extolled for its virtues in the cure of epilepsy, and other spasmodic diseases, when it was used in small doses. Much larger quantities of it, however, have been administered lately, and its character of efficacy has been considerably diminished. The sulphat of zinc, or white vitriol, appears to be a more efficacious tonic. Arsenic has more recently been introduced as a remedy for epilepsy. The safety and great powers of this metal, as a medicine, especially in the cure of periodical disorders, such as intermittent fevers, megrim, or intermittent head-ache, &c. have been fully established, and afford an analogy in its favour. A writer on this subject, in the Edin. Med. and Surg. Journal (for July 1809) states, that he has found arsenic successful in the cure of epilepsy, when it "occurred in young subjects, principally anterior to the age of puberty, and of what is termed a delicate make, and feeble stamina, especially when the disease assumes, or very nearly approaches, a periodic form. The drunken epileptic likewise, when not of a full plethoric habit, has found a cure from the firm and judicious use of this potent remedy, due attention having been paid to the alvine evacuations." There is still another tonic of the metallic class, which has lately been recommended as an efficacious remedy for epilepsy, the nitrat of silver (or lunar caustic), and is said to have cured the disease, when it had already been of many years standing. (See two cases of this nature, Med. and Phys. Journal, vol. i. p. 184. vol. ii. p. 70.) A quarter of a grain of this active substance, given three times a day, is a sufficient dose for an adult in the beginning; it may be afterwards carefully increased.

The vegetable tonics are admitted to possess less efficacy in alleviating this dreadful disorder. Among these the bitters have chiefly been employed, and the cinchona is the most active. Like the arsenic, it is especially adapted to those epilepsies which recur at certain periods, and which are not at the same time accompanied with any plethoric state, or turgescence of the blood: in such periodical cases, if the bark is employed some time before the expected recurrence, it may be useful; but it must be given in large quantity, and as near to the time of the expected recurrence as possible. The leaves of the orange tree have sometimes proved useful in this disease, probably by the bitter quality which they possess.

But this caution must again be given, with respect to the employment of any of the above-mentioned tonics in this disease, that in all cases where it depends upon constant or occasional plethoric state of the system, these medicines are likely to be at least ineffectual; and if sufficient evacuations be not made at the same time, they are likely to be very hurtful. The various success with which such remedies have been administered is, doubtless, to be ascribed partly to inattention to these circumstances; although it is equally clear, that many epilepsies, connected with organic lesion in the head, or a connate disorder of the habit, are beyond the power of any medicine.

With a view of diminishing the tendency to the convulsions of epilepsy, various antispasmodic medicines have been employed,

employed, such as valerian, castor, musk, the foetid gums, empyreumatic oils, and other substances of strong and offensive odour. But, although these remedies were generally administered at one period, and were much extolled for their antispasmodic powers, they seem to have lost their high character, in a great measure, and are much less employed than heretofore.

Several remedies have also been introduced, as *specifics*, in the disease in question; *i. e.* as remedies which possessed a peculiar influence over it, independently of any sensible quality or operation. Such are the viscous quercinus, or mistletoe, the cardamine pratensis, agaricus muscarius, &c. Experience has not sanctioned the recommendation of these medicines, which appear to be nearly inert. If the mistletoe were ever beneficial, it was probably in those times when it was an object of religious superstition, and operated through the medium of an impression on the mind. On the same principle, taking remedies that excited horror may have sometimes succeeded in curing the disease; such as the powder of human skulls, (*pulvis cranix*,) &c. A pamphlet has been published lately, however, in which the specific efficacy of the mistletoe is again contended for by Dr. H. Frazer. But the cases, there related, are mentioned so briefly and uncircumstantially, that no just inference as to the means of cure can be deduced; and the weight of negative evidence is, on the other hand, so great, that we are disposed to attach little credit to the mistletoe. We have employed it, since the publication of the pamphlet alluded to; but without any effect.

Dr. Fothergill, whose experience and sound observation led him to infer, that plethora was the most frequent cause of curable epilepsies, and the system of diet and evacuation, before mentioned, the most effectual means of cure, was disposed to attribute the reputed efficacy of all the last-named remedies for epilepsy to a very different operation, than was intended by the prescriber: namely, to their impeding digestion, and consequently preventing incurring plethora. "Valerian," he says, "castor, the foetid gums, empyreumatic oils, and, if there be any thing still more disgusting, commonly make a part of the medicines proposed for this disease. There are some others, whose qualities, indeed, are not quite so repugnant to our taste and smell, such as the mistletoe, and the *flores cardamines*; but to balance this difference, it is requisite to take these such a length of time, and in such quantities, as make them not less disgusting at length. May not, therefore, both these kinds of medicines, and most of those made use of as specifics from ancient authority, now and then confirmed with instances of benefit, derive the greatest part of their consequence from their quantity, or their disgusting qualities, which, by lessening the appetite, allow nature to recover herself, and shake off a disease, which indulgence principally produced." (*Med. Obs. and Inquir. vol. vi. p. 77.*)

The sight of others in a fit of epilepsy is the most common of the mental irritations which produce epilepsy: this, therefore, should be guarded against, especially among children, and more particularly in a family where epilepsy has already appeared. The famous cases of epilepsy, thus communicated among the orphans at the hospital at Haerlem, are well known; (*see CONVULSIONS*,) as well as Boerhaave's successful cure, by threatening a severe punishment (burning with a hot iron) to the first who should be seized with a fit. This counter-impression upon the mind, which Dr. Cullen whimsically terms the *tonic* of fear, was sufficient to obviate the effects of the other. (*See KAUU Boerhaave impetum faciens, § 4:6.*)

Some anti-epileptic powers have been attributed to opium,

hyoscyamus, or henbane, digitalis, and some other sedative medicines; but it is obvious that these substances can only be serviceable in those cases where the disease depends upon irritation, or increased irritability, when their effects will be temporary; and that, when there is any plethoric or inflammatory condition present, they must, with the exception of digitalis, prove hurtful, especially opium.

With respect to the fit itself nothing can be done, in general, except restraining the patient from injuring himself. He should be removed from the ground, or from the vicinity of any hard body, against which he might be bruised by the convulsive motions of the limbs; and in those cases in which the tongue is apt to be protruded, and lacerated by the teeth, a sort of gag should be introduced. In very plethoric habits, where the determination of blood to the head is very great, it may be advisable to open a vein during the fit, in order to obviate the immediate danger of life, from a rupture of the vessels of the brain.

When the fit is preceded by an *aura*, as before mentioned, which has been supposed to arise from irritation propagated along the course of some particular nerve, various means of preventing the fit have been suggested; such as destroying the part, in which the *aura epileptica* arises, by means of the knife or caustic, applying a blister, or making an issue in it, or cutting the branch of the nerve along which the *aura* seems to pass, or lastly, applying a ligature upon the limb, above the part from which the *aura* arises. A tourniquet has been recommended for the last purpose, to be worn loose upon the limb, and tightened the instant that the *aura* is perceived; by which means the epilepsy has been said to have been prevented in several instances.

On dissection after death from epilepsy, a variety of morbid and preternatural appearances have been in the head, to which the symptoms might be justly attributed, in consequence of the mechanical irritation of the brain. Thus irregularity in the arrangement of the bones, or some other malformation of the cranium, inequalities or protuberances on its interior surface, splinters, or depression of the bones from fracture; tumours, thickening, and ossification in the membranes enveloping the brain; fluids of various acrimony effused, or collected within the brain, or on its surface, and tumours formed in the substance of the brain; have in various instances been discovered after epilepsy had proved fatal.

EPILESMON, from ἐπιληδω, *I cause to forget*, a term used by the old writers in *Medicine*, to express a loss of memory.

EPILOBIUM, in *Botany*, a name adopted by Conrad Gesner, and explained by him as indicative of the character of this genus, ἐπι λοβω ων, *a violet*, or beautiful flower, growing upon a pod; in which he is followed by Dillenius and Linnæus. See Bauhin's *Pinax* 245, sect. 7; *Dill. Plantæ Agri Giffensis*, 132; and *Linn. Phil. Bot.* 176. Willow-herb.—*Linn. Gen.* 188. *Schreb.* 251. *Willd. Sp. Pl. v. 2.* 313. *Sm. Fl. Brit.* 409. *Mart. Mill. Dict. v. 2.* *Juss.* 319. *Geortu. t. 31.* (*Chamænerion*; *Tourn. t. 157.*) Class and order, *Oëandria Monogynia*. Nat. Ord. *CalycantHEME*, *Linn. Onagrea*, *Juss.*

*Gen. Ch.* *Cal.* Perianth superior, of one leaf, deeply four-cleft; segments oblong, pointed, coloured, deciduous. *Cor.* Petals four, roundish, broadest upward, cloven, spreading, inserted into the calyx between its segments. *Stam.* Filaments eight, awl-shaped, alternately shorter; anthers oval, compressed, obtuse. *Pist.* Germen inferior, cylindrical, very long; style thread-shaped; stigma thick, obtuse, either undivided or four-cleft, the lobes revolute, downy. *Peric.* Capsule very long, cylindrical, with four furrows,

four cells, and four valves, with a longitudinal linear partition originating from the centre of each. *Recept.* columnar, square, its angles attached to the partitions, which at length separate from it. *Seeds* numerous, oblong, crowned with down, and affixed in two rows to each angle of the receptacle.

*Eff. Ch.* Calyx in four deep segments. Petals four. Capsule oblong, inferior. Seeds feathered.

An elegant genus of plants, with flowers of a paler or deeper rose-colour, natives of watery or boggy situations, chiefly in the cooler or mountainous parts of Europe. The roots in all are perennial, and often creeping. *Leaves* undivided. *Flowers* spiked or racemose, terminal. *Stamens* in some direct, in others declining.

The species in Willdenow are twelve, to which are to be added *E. roseum*, Schreb. *Lipf.* 147. *Sm. Fl. Brit.* 411. *Engl. Bot. t.* 693, and *E. alpinifolium*, Villars *Dauph. v.* 3. 511. *Engl. Bot. t.* 2000, both by him made varieties of *E. montanum*. The British species therefore, at present ascertained, are nine.

*E. angustifolium*, Linn. *Sp. Pl.* 493. *Curt. Lond. fasc.* 2. t. 24. *Engl. Bot. t.* 1947, called the French or Persian Willow, or Rosebay Willow-herb, is one of the most handsome, though most common, of the whole. It rarely with us occurs wild, but thrives and blossoms abundantly in any garden, whether the situation be moist or dry, even in almost any part of London. Linnæus says, *Fl. Lapp. n.* 146, "it frequently, like a garden, surrounds the hut of the wild Laplander, who vies with Diogenes in the simplicity of his household furniture, but whose habitation seems the palace of a divinity, when this stately plant is in bloom." This is an instance, among many, of a truly alpine plant succeeding well in the smoke of a city, while others require the purest air possible.

**EPILOGUE, EPILOGUS**, in *Oratory*, &c. The peroration, or last part of a discourse, or treatise; containing ordinarily a recapitulation of the principal matters delivered.

The word is Greek, ἐπιλογεῖς, formed of the verb ἐπιλάβε, *I say after*; the epilogue being the end, or conclusion of a discourse.

**EPILOGUE**, in *Dramatic Poetry*, is a speech addressed to the audience, when the play is over, by one of the principal persons or actors in the piece; containing usually some reflections on certain incidents in the play, particularly those of the part of the person who speaks it.

In the modern tragedy, the epilogue has usually somewhat of pleasantry in it; intended, perhaps, to compose the passions raised in the course of the representation, and send the audience away in good humour; though how far that design is good and laudable will bear some dispute: an ingenious author in the *Spectator* compares it to a merry jig on the organ, after a good sermon, to obliterate any impressions that might have been made thereby, and send the people away just as they came.

In effect, though the epilogue, in this sense, may seem an abuse, yet has it the countenance of antiquity; the Romans had something of the same nature, though under another name. Their exodium was a kind of farce, brought on the stage when the tragedy was over: "ut quicquid lacrymarum ac tristitiæ cepissent ex tragicis affectibus, hujus spectaculi risu detergeret," says the scholiast of Juvenal. The epilogue is but of modern date, much later than the prologue. Many, indeed, have taken the exodium of the ancient Greek drama for an epilogue, because Aristotle defines it to be a part rehearsed after the chorus had sung for the last time; but in reality, it was of a quite different nature. The exodium was the last of the four parts of the

tragedy: containing the unravelling and catastrophe of the plot, and answering to our last, or fifth act.

**EPIMEDIUM**, in *Botany*, as at present understood, is certainly different from the ἐπιμηδίου of Dioscorides, which seems to be *Osmunda Lunaria*, though his description does not exactly agree even with that plant. The derivation of the name has always appeared obscure. Ambrosini deduces it "from ἐπιμύω, to close, or shut up, because the leaves conceal the flowers; or from ἐπιμύδα, because of its growing frequently in Media." Neither of these is satisfactory, and the word seems rather to have a reference to the plant μύδιον, a *Campanula*, or something very near that genus, which immediately precedes it in Dioscorides. However this may be, the name *Epimedium* is now universally applied to the Barren-wort. *Linn. Gen.* 59. *Schreb.* 79. *Willd. Sp. Pl. v.* 1. 660. *Sm. Fl. Brit.* 187. *Prod. Fl. Græc.* 103. *Mart. Mill. Dict. v.* 2. *Juss.* 287. *Tourn. t.* 117. Class and order, *Tetrandria Monogynia*. Nat. Ord. *Corydalis*, Linn. *Berberides*, Juss.

*Gen. Ch.* Cal. Perianth inferior, of four ovate, obtuse, concave, small, spreading, deciduous leaves, placed directly under the petals. *Cor.* Petals four, ovate, obtuse, concave, equal, spreading. Nectaries four, pouch-shaped, blunt at the base, the size of the petals and lying upon them, fixed to the receptacle by the edge of their orifice. *Stam.* Filaments four, awl-shaped, pressed close to the style; anthers oblong, erect, of two cells and two valves, the latter separating from their base upwards, leaving the partition free. *Pist.* Germen superior, oblong; style shorter than the germen, as long as the stamens; stigma simple. *Peric.* Pod oblong, pointed, of one cell and two valves. *Seeds* numerous, oblong.

*Eff. Ch.* Petals four. Nectaries four, pouches lying on the petals. Calyx opposite to the petals, caducous. Pod superior, of one cell, with many seeds.

*E. alpinum*, Linn. *Sp. Pl.* 271. *Engl. Bot. t.* 438. *Fl. Græc. ined. t.* 150. *Ger. em.* 480. The only species, a native of shady mountainous places in several parts of Europe, not very difficult of cultivation in our gardens, flowering in May. The root is perennial, creeping, slender, blackish. *Stems* upright, simple, about a foot high, round, smooth, bearing one large, twice or thrice compound leaf, divided irregularly in a three-fold order, and composed of large, pendent, tremulous, thin, delicate, heart-shaped, pointed, finely ciliated, smooth leaflets, glaucous beneath; and one upright panicle, alternately branched, whose stalks are red, and rough with glandular hairs. *Flowers* singular and elegant, drooping, with dark red petals, and yellow pellucid nectaries. Dr. Smith, in his *English Botany*, suggests that "perhaps what is called the stem ought to be reckoned only the foot-stalk of the leaf, which, as in *Turnera*, bears the flower-stalk."

**EPIMENIDES**, in *Biography*, a Cretan philosopher and poet, who was contemporary with Solon, and of whom many fables are related. Among others it is said, that, being sent by his father in search of a straying sheep, he slept in a cave, where he reposed himself for 50 years, and when he awoke, found to his surprise, that he was become an old man, that every thing about him was become new and strange. It is also recorded of him, that he could dismiss the soul from his body, and recal it at pleasure; and that he had familiar intercourse with the gods, and possessed the gift of prophecy. Most of these fictions may probably have originated with the Cretans, who were, to a proverb, famous for their powers of invention. (*Titus, i.* 12.) The more credible account of Epimenides is, that he was a man of superior talents, who pretended to intercourse with the

the gods, and in order to justify his pretensions, lived in retirement upon the spontaneous productions of the earth, and practised various arts of imposture. At the time of his pretended inspiration he might, possibly, have the art of appearing totally insensible and entranced, which would be considered by ignorant and deluded spectators as a power of dismissing and recalling his spirit. Such was his reputation for sanctity, and for the performance of religious rites, that, during a plague in Attica, which happened in the 46th olympiad, about 596 years B.C., the Athenians sent for him to perform a sacred lustration; in consequence of which, as it is said, the gods were appeased and the plague ceased. Of this ceremony we have given a particular account under the article ALTAR. On occasion of this visit to Athens, Epimenides became acquainted with Solon, the Athenian legislator, who is said to have disapproved the conduct of the Athenians in this instance of superstition; and yet availed himself of the advice of the philosopher in compiling his celebrated code. The Athenians, however, were delivered from the pestilence, and were disposed liberally to requite Epimenides for his services. The philosopher declined accepting their offered recompence, and contented himself with a branch of the sacred olive, which grew in their citadel, and with this he returned to his native country, after having concluded a league between the Gnoſſians of Crete and the Athenians. Soon after his return to Crete he died, as Laertius says, at the age of 157 years, or, as the Cretans pretend, at the age of 299 years. The superstitious Cretans paid him divine honours after his decease; and he has been reckoned by some the 7th wise man of Greece, to the exclusion of Periander from this number. Laertius enumerates a variety of pieces written by Epimenides, both in prose and verse. Among the former was a treatise "On Sacrifices," and "An Account of the Cretan Republic;" and among the latter "The Genealogy and Theogony of the Curetes and Corybantes," in 5000 verses; "Of the Building of the ship Argo, and Jason's Expedition to Colchis," in 6500 verses; "Of Minos and Rhadamanthus," in 4000 verses; and a treatise "Of Oracles and Responses," mentioned by St. Jerome, from which St. Paul is said to have taken the quotation in his epistle to Titus, ch. i. 12. Laert. l. i. c. 10. Brucker's Hist. Phil. by Enfield, vol. i.

EPIMETRON, ἐπι and μέτρον, *measure*, in *Antiquity*, an allowance given the tax-gatherers in the Roman provinces, over and above the just quantity of wine or grain they were obliged to furnish. The epimetron, or over-measure, in different provinces, was different, being always greater in those that were remote, than in the nearer provinces. The different kinds of things wherein it was given made likewise a difference in the quantity allowed. The reason of allowing an epimetron, or over-measure, was to make good the leakage of the wine and waste of grain, that would necessarily happen by transporting it to Rome.

The provinces whose taxes were converted into money, and paid in specie, were free from epimetron.

EPIMORIOS, Ἐπιμοριος, *superparticular*, of μέτρον, *I divide*, an epithet given by Galen to certain differences in the pulses with respect to their inequality as to the time of their beating. All times, rythms, or modulations of the pulse, according to number, consist, he observes, of equal or unequal proportions. Of equal, when the time of the distension is equal to that of contraction; and of unequal, when the one of these exceeds the other; and this inequality may be from certain or uncertain excesses. The certain excesses may be either in multiple proportion, or as number to number, which is the epimorion.

EPIMULIS, ἐπι, upon, and μύλη, *whirl* done on the top of the knee, a name given, by some anatomists, to the patella, or knee-pan.

EPIMYLIA, in the *Ancient Music*. We are told, in Athenæus, that the epimylia, and the song called "Hymæus," were the same (see ΗΥΜÆΥΣ): Athenæus adds, that it is probable that the word epimylia comes from ἐμύλη, which in Dorian signifies sometimes the return, and sometimes the augmentation and surplus of nourishment given to those who labour at the mill. But perhaps after all, this word comes from μύλα, a mill.

EPIMYTHION, Ἐπιμυθιον, in *Rhetoric*. See TABLE.

EPINA, or HARPINA, in *Ancient Geography*, a town of Triphylia, upon the river Parthenia, N. of Phryga.

EPINAC, in *Geography*, a small town of France, in the department of Saône and Loire, chief place of a canton in the district of Autun, with a population of 1128 individuals. The canton contains 11 communes and 5802 inhabitants, on a territorial extent of 155 kilometres.

EPINAL, or ESPINAL, a town of France, in the department of the Vosges, chief place of the district of the same name, with a population of 7321 individuals. It is situated on the river Moselle, 12 miles N.W. of Remiremont, and 480 miles of Paris, and 42 miles S.E. of Nancy. N. lat. 48° 22'. The canton has a territorial extent of 297½ kilometres, 19 communes, and 14,709 inhabitants.

As chief place of a district, Epinal has a sub-prefect, a ranger, a brigadier-general, who commands in the department, a captain of the national gendarmerie, two courts of justice, and a register office. It has several paper-mills. The soil produces wheat, rye, oats, hemp, and flax. Its principal trade is with hemp and flax, hemp and flax seed, oil, and the produce of a few manufactures of linen and cotton stuffs, and writing paper. The whole district comprises five cantons, 116 communes, and 62,592 inhabitants, on a territorial extent of 1285 kilometres.

EPINAY, a small town of France, in the department of l'Ille and Vilaine; three miles W. of Vitré, which, before the revolution of 1789, conferred the title of marquis on the lord of the manor.

EPINENEUCOS, from νευω, *I nod*, in the old writers of *Medicine*, a word used to denote a sort of unequal pulse, beating differently in the different parts of the same artery; as when it rises strongly against the two middle fingers of the physician who feels it, and weaker at the extremes; this sort of pulse is described by Galen as common to hectic patients, and is called also perineneucos.

EPINEPHELOS, of ἐπι and νεφελον, *clouds*, in the *Writings of the Ancient Physicians*, a term used to express the cloudy matter seen floating in the urine in fevers, &c. See ENOPREMA.

EPINETTE, *Fr.* in *Music*. See SPINET.

EPINEU le Chevreuil, in *Geography*, a town of France, in the department of the Sarthe and district of Sillé; 12 miles W. of Le Mans.

EPINEUL, a town of France, in the department of the Yonne, and district of Tonnerre; 1½ mile N. of Tonnerre.

EPINEUX des Lombes, in *Anatomy*, a name given by Winslow, and some other of the French authors, to certain small muscles of the loins, not mentioned by the old anatomists; but called by Albinus interspinales lumborum.

EPINICINION, Ἐπινοικιον, in the *Ancient Music*, a song of victory, by which the Greeks celebrated the triumph of conquerors.

EPINICION, Ἐπινοικιον, from ἐπι, on, νικη, *victory*, in

the *Greek and Latin Poetry*, denotes, 1. A feast, ceremony, or rejoicing, on occasion of a victory obtained. 2. A poem or composition, on the same subject. Scaliger treats expressly of the epinicion in the *Poetics*, lib. i. cap. 44.

EPINOI, in *Geography*, a small town of France, in the department of the North; 9 miles S. of Lille, and 9 miles N. of Douai.

EPINYCTIS, (from *επι*, and *νύξ*, night,) in *Surgery*, a kind of pustule, of the nature of the furunculus, originating in the night-time; or, according to *Ætius* and *Paulus*, attended at this period with the most pain.

EPIODIUM, in the *Ancient Music*, a funeral song or dirge with the Greeks; called *Mænia* by the Romans.

EPIPACTIS, in *Botany*; according to *Hederic*, from *επιπυκνωσις*, or *επιπυκνωσ*, to congeal, or to grow together at the summit. In this sense the name may very well apply to the *Helleborine* of some authors, for which *Haller* and *Swartz* retain it, and which has always been taken for the *επιπυκνωσις* of *Dioscorides*, whose account of the matter is too short and vague to afford much light. The petals of this plant do indeed approach each other, towards the upper part, more than in many of the *Orchideæ*, and such an explanation is more correct than that of *Ambroini*, who derives the word from *παγος*, ice, or *πυκνωσις*, frozen, "because the herb grows in very cold places, as it were upon or above the ice," which circumstance by no means applies to it. *Haller* in *Aët. Helvet.* v. 4. 100. *Hist. Stirp. Helvet.* v. 2. 147. *Swartz. Aët. Holm.* 1800. p. 231. t. 3. f. N. *Traacts on Botany*, 159. *Schrad. Neues Journ.* v. 1. 62. *Willd. Sp. Pl.* v. 4. 83. (*Helleborine*; *Tourn.* t. 249. *Serapias*; *Linn. Gen.* 462. *Schreb.* 503. *Juss.* 65. *Gærtn.* t. 14.) *Class and order, Gynandria Monandria. Nat. Ord. Orchideæ.*

Gen. Ch. reformed. *Cal.* three-leaved; leaflets direct, a little spreading, concave, acute. *Cor.* Petals two, rather smaller than the calyx, slightly spreading. *Nectary* a lip proceeding from the lower part of the style, tapering, or concave, or keeled, at the base, usually longer than the calyx, deflexed, entire or cloven, concave or flattish, often furrowed above. *Stam.* Anther an hemispherical, moveable, permanent, terminal lid, of two cells, attached by its posterior edge to the top of the style; masses of pollen oblong, powdery, granulated, sometimes lobed. *Pist.* *Germen* inferior, obovate, erect, furrowed, sometimes twisted; style erect, roundish, notched at the top; stigma in front, oblique, under the anther. *Peric.* Capsule inferior, oval, with six ribs and one cell, opening by clefts between the ribs. *Seeds* numerous, minute, tunicate.

Ess. Ch. reformed. *Calyx-leaves* direct, slightly spreading. *Lip* without a spur. *Anther* a terminal permanent lid. *Pollen* powdery, granulated.

*Swartz* and *Willdenow* enumerate fourteen species of this genus, eight or nine of which are British. They are divided into two sections, eight of them having an undivided lip, and six a cloven one. The former are,

1. *E. latifolia.* (*Serapias latifolia*; *Linn. Syst. Veg.* ed. 14. 814. *Sm. Fl. Brit.* 942. *Engl. Bot.* t. 269.) A native of cool, shady, rather mountainous woods, throughout Europe. The roots are perennial and creeping. *Stems* simple, about two feet high, leafy, roughish. *Leaves* ovate, or broad-lanceolate, ribbed and plaited, clasping the stem alternately. *Flowers* in a long terminal spike, with bractees at least as long as the germen, the lower ones longer than the whole flower. *Calyx* and *petals* of a brownish green. *Nectary* shorter than either, heart-shaped in front, purplish, acute,

2. *E. palustris.* (*Serapias palustris*; *Scop. Carn.* v. 2. 204. *Lightf.* 527. *Sm. Fl. Brit.* 943. *Engl. Bot.* t. 270.) An elegant native of watery, boggy meadows, in England and other parts of Europe, flowering in July and August. The flowers are fewer, but larger and more specious than the last, being variegated with white, purple and yellow, and the lip is crenate. *Linnaeus* has called this *S. longifolia*, but very incorrectly, and from mistake.

3. *E. microphylla.* *Sw.* (*Serapias parvifolia*; *Ehrh. Herb.* 120.) A native of Germany and Switzerland; possibly also of England, as we have some suspicion of its being the *Helleborine altera*, *atrorubente flore*, of *Ray's Synopsis*, 383. It most resembles the first species, but has much smaller leaves.

4. *E. grandiflora.* (*E. pallens*; *Sw. Serapias grandiflora*; *Sm. Fl. Brit.* 944. *Engl. Bot.* t. 271.) Frequent in the beech woods of Berkshire and other midland counties of England, flowering in June. The flowers are few, closed, large and elegant, white with yellow lines upon the lip. *Leaves* elliptical.

5. *E. ensifolia.* *Willd.* (*Serapias ensifolia*; *Sm. Fl. Brit.* 945. *Engl. Bot.* t. 494. *S. xiphophyllum*; *Linn. Suppl.* 404.) Confounded by *Haller*, *Hudson* and others with the last, from which it differs in its minute bractees, narrower and longer leaves, shorter lip, and more slender germen. It grows in Switzerland, and very rarely in the mountainous parts of Yorkshire and Worcestershire.

6. *E. rubra.* (*Serapias rubra*; *Linn. Syst. Veg.* ed. 14. 816. *Sm. Fl. Brit.* 946. *Engl. Bot.* t. 437.) Native of shady mountainous woods in several parts of Europe, rare in England. It is distinguished by its elegant rose-coloured flowers, whose lip is marked with yellow wavy ridges, and auricled at its base.

7, 8. *E. erecta* and *falcata*, natives of Japan, are the only remaining species of this section; and these, as *Willdenow* observes, appearing to have a spur to the flower, are perhaps species of *Limodorum*.

The species in *Swartz* and *Willdenow* with a cloven lip are,

9. *E. Nidus avis.* (*Ophrys Nidus avis*; *Linn. Sp. Pl.* 1339. *Sm. Fl. Brit.* 931. *Engl. Bot.* t. 48.) A parasitical plant, growing in shady beech woods, chiefly on a chalky soil, and singular for its uniform pale brown hue. The root consists of numerous clustered juicy fibres. *Leaves* none, except small scales on the stem. *Flowers* numerous, forming a dense spike, inodorous, with a cloven divaricated lip.

10. *E. ovata.* (*Ophrys ovata*; *Linn. Sp. Pl.* 1340. *Sm. Fl. Brit.* 932. *Engl. Bot.* t. 1548. *Curt. Lond. fasc.* 3. t. 60.) Frequent in woods, flowering in June like most of its genus. The stem, a foot high, bears only two opposite, broad, oval leaves, and a spike of numerous small green flowers, whose long pendulous lip produces a small drop of honey in front, thus proving its right to the title of nectary. See *Sm. Intro. to Botany*, 461.

11. *E. cordata.* (*Ophrys cordata*; *Linn. Sp. Pl.* 1340. *Sm. Fl. Brit.* 933. *Engl. Bot.* t. 358.) Grows on boggy mountainous heaths in Scotland and the north of England, as well as in Switzerland, &c. It is scarcely a quarter so large as the last, and has heart-shaped leaves, and a four-lobed lip.

12. *E. convallarioides.* *Sw.* in *Web. and Mohr. Beitr.* v. 1. t. 1. (*Ophrys cordata*; *Michaux Fl. Boreali-Amer.* v. 2. 158.) Native of the West Coast of North America, and of Newfoundland. A slender delicate species, with a pair of roundish heart-shaped leaves, capillary racemose flower-stalks, narrow calyx and petals, and a dilated lip.

13. *E. camtschatea*. Sw. and Willd. (*Ophrys camtschatea*; Linn. Sp. Pl. 1343. Neottia; Amæn. Acad. v. 2. 361. t. 4. f. 24.) Native of Siberia. Destitute of leaves, except a few sheathing scales. The flowers are much like the last, but have a more linear nectary.

14. *E. unifolia*. (*E. porrifolia*; Sw. and Willd. *Ophrys unifolia*; Forst. Prod. 59.) Found by Forster in New Zealand. The leaf is solitary and sheathing, rising above the stalk, which it embraces, and which bears a short dense spike of small flowers. We see no advantage in changing the original specific name.

EPIPEDOMETRY, of *επι*, *παις*, *foot*, and *μετρος*, *I measure*, in *Mathematics*, signifies the measuring of figures that stand on the same base.

EPIPETRON, in *Botany*, a name given, by Theophrastus and Aristotle, to a plant, supposed by many to be the same with the empetrum of Dioscorides. But there is great reason to doubt whether the epipetron of the two older authors be the same plant; and whether, if they mean two different plants by this name, either of them agree with the empetrum of Dioscorides. Theophrastus says, that his epipetron never flowers: and Aristotle says, that his epipetron grows on rocky places, and continues to grow after it is taken up, as the orpin and some other plants will do.

EPIPHÆNOMENA, of *επι* and *φανομενον*, *symptom*, in the *Writings of the Ancient Physicians*, a term used to express such of the symptoms, in certain diseases, as did not usually appear till the time that the disease was actually formed, called also epiginomena.

EPIPHALLUS, in the *Ancient Music*. It appears by a passage in Eustathius, often quoted by Meursius, that this was also the name of a dance, performed to flutes.

EPIPHAN, in *Geography*, a town and district of Russia, in the government of Tula, situated on the Don.

EPIPHANES. See EPIPHANIUS. This term in Greek, *Επιφανης*, denoted eminent or illustrious, and thus it was applied to Antiochus, which see.

EPIPHANES, of *επι* and *φανομαι*, an epithet given to Jupiter, because he manifested his presence by lightning and thunder, &c.

EPIPHANIA, a word used, by some of the ancient physicians, to express the external habit of the body.

EPIPHANIA, in *Ancient Geography*, a town of Asia Minor, in Cilicia, near the Mediterranean, between the branches of mount Amanus, on the river Carus; probably denominated Epiphania in honour of Antiochus Epiphanes, king of Syria, who possessed Cilicia. We learn from Tacitus, that the part in Cilicia, in which this town was situated, became subject to the dominion of Rome under Lucullus, about the year of the city 683. It was afterwards episcopal under the metropolis of Anazarba.

EPIPHANIA on the *Euphrates*, a town of Asia, situated on that river.

EPIPHANIA, a town of Syria, on the Orontes; which was subjected to the Romans about the year 690, during Pompey's expedition into the territory of Apamæa and into Coele Syria. This town was situated between Larissa and Arethusa; and it was reckoned by the Orientals one of the most ancient towns in the world, founded, as they imagined, by Hamath, one of the sons of Canaan; and that its name was changed by the Macedonians in honour of Antiochus Epiphanes. (See HAMATH.) It was episcopal under the metropolis of Apamæa.

EPIPHANIA, a town of Asia Minor, in Bithynia. Steph. Byz.—Also, a town of Asia, on the banks of the Tigris, called by Steph. Byz. *Arseicerta*.

EPIPHANIUS, or EPIPHANES, in *Biography*, the son of Carpocras, or Carpocrates, an heresiarch in the second century, was instructed by his father in the whole circle of the sciences, and particularly in the Platonic philosophy; but his death, when he was 18 years of age, disappointed the hopes which the Carpocratians entertained concerning him. After his death he was honoured by them as a god, particularly in the island of Cephalonia, where a temple was erected to him, with altars, a grove, and a museum, and where the day of his nativity was celebrated with hymns, libations, sacrifices, and feasting. These are the reports of Clement of Alexandria and of Epiphanius; unconfirmed by the testimony of other writers. Epiphanius is now classed with the Valentinians. Lardner Hist. Heret. c. iii. § 1.

EPIPHANIUS, bishop of Salamis in the island of Cyprus in the fourth century, and dignified by the Catholics with the title of Saint, was born in the vicinity of Eleutheropolis, in Palestine, about the year 320. In his youth he went into Egypt, where he inclined to the sect of the Gnostics, but separating from them, he joined himself to the Egyptian Ascetics, imbibing their principles and conforming to their manners. In his 20th year he returned to his own country, and became a disciple of Hilarion, the father of Palestine monkery. After some time he founded a monastery at Bezanduce, the village in which he was born, over which he presided for the greatest part of his life. In 367 or 368, he was appointed bishop of Salamis, afterwards called Constantia, where his piety and sanctity were held in high estimation, and where he was assiduously employed in writing defences of the orthodox doctrines against the attacks of heretics. His zeal, however, involved him in many troubles, which embittered a considerable portion of his life. One of the principal circumstances which contributed to embarrass and embroil him, and to entail disgrace on his memory, was his inveterate opposition to the opinions of Origen. This produced a contest with John bishop of Jerusalem, who favoured these opinions, which, after many mutual invectives and recriminations, terminated in a breach between the two bishops, that convulsed the eastern churches by the hatred and persecuting spirit manifested in the conduct of their respective partisans. Theophilus, bishop of Alexandria, was an active adherent to the cause of Epiphanius, and held a council in 399, which condemned the writings of Origen, and prohibited all persons from reading them, or having them in their possession. This example was followed by a council of the bishops of Cyprus, summoned by Epiphanius himself in the year 401. Failing of success by the decrees of these councils and by the persecution against Origen, which they were the means of instigating, the determined and zealous prelate took a voyage to Constantinople, in order to induce the bishops in that city to adopt and sanction the decrees of Alexandria and Cyprus. On his arrival, he declined holding any intercourse with Chrysofom, bishop of that city, unless he joined in the condemnation of Origen, and in withdrawing his protection from the exiled Egyptian monks. Exasperated by the disappointment of his views, he resolved to present himself to the people in the church of the Apostles, and openly to condemn the books of Origen, and all his advocates. But before he could execute his purpose, he was warned of the irregularity of his proceedings, and of the sedition which they might occasion; and he, therefore, thought it most prudent to abandon his design. His next attempt was that of interesting the court in his favour; and so violent and implacable was his zeal against those who favoured Origen, that

that when the empress Eudoxia besought his prayers in behalf of the younger Theodosius, who was dangerously ill, he assured her that he should not die, if she would consent to discard the heretics, who were sheltered under the imperial patronage. The princess very properly reproved this arrogant and impious message; and his impetuosity was also checked by the Egyptian monks, who convicted him of being unacquainted with the principles of the persons, against whom he had been indeliberately exciting universal indignation. Thus foiled and abashed, he set out on his return to Cyprus, and died either on his voyage, or soon after his return, in the year 402 or 403, at a very advanced age. The piety of Epiphanius was unquestionable; but it was blended with a gloomy superstition, which led him to promote the austere discipline of the cloister, and to employ his episcopal influence in multiplying monastic institutions. In offices of charity for the relief of the indigent, he expended not only his own private fortune, but the greatest part of the revenues of his church, and large sums entrusted to his disposal. His learning was considerable, for, according to St. Jerome, who mentions him in terms of high commendation, and calls him *πενταγλωσσος*, a man of five languages, he understood Greek, Syriac, Hebrew, Egyptian, and partly Latin. It is allowed, however, that he was deficient in judgment, and unskilful in wielding the weapons of controversy. Careless in his transcripts from ancient authors, and credulous in admitting unauthenticated reports, he has been betrayed into various contradictions and absurdities, so that his works, with respect to authority and reference, are depreciated in value. His style is mean, harsh, and unpolished, without perspicuity, and without connection. In his remaining works he has given several catalogues of the books of the Old and New Testament. His canon of the Old Testament was much the same with that of the Jews. (See CANON.) The books of the New Testament received by him are the same with those generally received by us. For both these classes of sacred books he professes the highest regard; nor does he ever make use of Christian apocryphal books, written in the name of apostles and falsely ascribed to them. With respect to the books of the New Testament, he says, that Matthew preached, and wrote his gospel in Hebrew, and that he was the only writer of the New Testament who used this language. He had heard, however, that the gospel of St. John, and the Acts of the Apostles, had been translated from Greek into Hebrew, and were in the library of the Jews at Tiberias. Matthew wrote first, and soon after Mark, who was Peter's companion at Rome. The third gospel, in his enumeration, was that of Luke. John wrote his gospel at the age of 90 years, and Epiphanius says, that it was occasioned by the errors of the Ebionites, the Cerinthians, the Merinthians, and Nazarenes. He ascribes the book of the Acts to Luke. He frequently quotes the epistle to the Hebrews as Paul's; he also cites the epistle of James, the two epistles of Peter, John's first and second epistles, and the Catholic epistle of Jude. He also received the book of Revelation. Of the baptism of Christ, he says, that it took place when he was 29 years and 10 months, thus understanding St. Luke's words, iii. 23. He says, there are two passovers in our Lord's ministry, according to St. John's gospel, and that he suffered at the third passover, in the 33d year of his life on earth; and therefore he did not think the "feast of the Jews," mentioned John, v. 1. to be a passover. He says, that the apostles did not preach themselves, but Jesus Christ, Lord. Therefore there was no sect, or church, called after the apostles; for we never heard of Petrians, or Paulians, or

Bartholomeans, or Thaddeans, but of Christians only; as they were called at Antioch. The works of Epiphanius were first printed in Greek at Basil by Oporinus in 1544; and the subsequent impressions have been numerous, of which the most valuable is that published at Paris in 1622, in two volumes folio, by the learned Petavius, who gave a new Latin version, with critical notes and observations. This edition was afterwards printed at Cologne in 1682, in two volumes folio. Cave's H. L. vol. i. sub sæc. Arian. Lardner's Works, vol. iv.

EPIPHANIUS, surnamed "The Scholastic;" a native of Italy, and an eminent Greek and Latin scholar, was born about the year 310. At the request of Cassiodorus he translated into the Latin language the ecclesiastical histories of Socrates, Sozomen, and Theodoret, a version more entitled to commendation for its fidelity than its elegance. Cassiodorus was also indebted to Epiphanius for the improved version of the "Codex encyclicus," or collection of synodal letters of the year 458, addressed to the emperor Leo, in defence of the council of Chalcedon. Cave H. L. vol. i. sub sæc. Eutych.

EPIPHANIUS, patriarch of Constantinople in the 6th century, strenuously vindicated the orthodox doctrines against the Eutychians, and after elevation to his dignity in the year 520, procured the condemnation of the latter in a synod of bishops held at Constantinople. Whilst he was patriarch, the decrees of the council of Chalcedon were confirmed, and a reconciliation was completed between the churches of Constantinople and Rome, after a schism which lasted 35 years. Five letters of this patriarch to pope Hormisdas on the subject of the union are extant in the 4th volume of the collection of the Latin councils. Cave H. L. vol. i. sub sæc. Eutych.

EPIPHANY, in *Ecclesiastical Antiquity*, the feast of kings; a double festival, of the first rank, solemnized on the sixth of January, commonly called "Twelfth day," in honour of the appearance of Jesus Christ to the three kings, or magi, who came to adore, and bring him presents.

The feast of Epiphany, now held in honour of the adoration of the magi, had its first institution among the Greeks, from a different object, viz. our Saviour's birth; and was called theophany, and epiphany, that is, appearance, and manifestation, of God.

Pope Julius, who reigned from the year 337 to 352, was the first who taught the church to distinguish the feasts of the nativity and epiphany. Papebroch. Paral. ad Conat. p. 23. Act. SS. Maii, tom. vii.

The word in the original Greek, *επιφανια*, signifies *appearance*, or *apparition*; and was applied, as some critics will have it, to this feast, on account of the star which appeared to the Magi. St. Jerom and St. Chrysostom, take the Epiphany for the day of our Saviour's baptism, when he was declared to men by the voice, "Hic est Filius meus dilectus, in quo mihi complacui: This is my beloved Son, in whom I am well pleased." And accordingly it is still observed by the Coptæ and Ethiopians in that view. (See Ludolph. Hist. Æthiop. lib. xxi. cap. 2.) Others contend, that the feast of Christmas, or the nativity of our Saviour, was held in diverse churches on this day; which had the denomination Epiphany, or appearance, because of our Saviour's first appearance on earth, as at that time. And it must be allowed, that the word is used among the ancient Greek fathers, not for the appearance of the star to the magi, but for that of our Saviour to the world. In which sense, St. Paul used the word *επιφανια*, *epiphania*, in his second epistle to Timothy, chap. i. ver. 10. Ammianus Marcellinus makes mention of this feast, lib. xxi. cap. 2.

and observes, that it was held in January. Upon which passage Valeſius, in his notes, endeavours to ſhew, that the hiſtorian meant by Epiphany the feaſt of the nativity.

The heathen writers uſed the word epiphania in the like ſenſe, *viz.* to expreſs the appearance of their gods on earth. And the Chriſtians, after their example, applied it, in the general, to expreſs any appearance, or manifeſtation of the Deity.

EPIPHEOS, in *Botany*, the name given by the ancients to the dodder, or *cuscuta*, which grew upon the ſhrub they called *phæos*. This was the ſtæbe of the modern Greeks, deſcribed by Honorius Bellus. It was a cuſtom, among the old writers, to name the *cuscuta*, or dodder, from the plant it was found growing upon, as they ſuppoſed that it in ſome degree partook of the virtues of that plant. Thus that which grew upon thyme was called *epithymum*, and that upon the nettle, *epiurteca*, and that upon flax, *epilinum*; ſo of many others.

The ſhrub *phæos* was alſo called *ſtæbe* by Dioſcorides and Theophrastus; and hence this dodder was ſometimes called *epiſtæbe*.

EPIPHLEBOS, of *επι* and *φλεβ*, a vein, in the *Writings of the Old Phyſicians*, a term uſed to denote ſuch perſons as were lean, and of a hot temperament, and whoſe veins, for that reaſon, appeared uſually very turgid and prominent in the hands, &c.

EPIPHLOGISMA, (from *επι*, and *φλογίζω*, to inflame,) in *Surgery*, a violent inflammation, accompanied with pain, ſwelling, and redneſs. Alſo, a great internal heat: likewiſe, the affection uſually called *eryſipelas*.

EPIPHONEMA, *Επιφωνημα*, *Acclamation*, in *Rhetoric*, a ſententious ſort of exclamation, which is frequently added after a narrative, or rehearsal of any thing remarkable; containing uſually a lively, cloſe reflexion on the ſubject there ſpoken of and intended to give it greater force, and render it more affecting to the hearers.

Such is that of St. Paul, when, after diſcourſing of the rejection of the Jews, and the vocation of the Gentiles, cries out,

“ O the depth of the wiſdom and knowledge of God !”

Such alſo is that of Lucretius, after relating the ſtory of Agamemnon's ſacrificing his daughter Iphigenia :

“ *Tantum religio potuit ſuadere malorum.*”

This figure is frequently expreſſed in a way of admiration. Such is that of Cicero, when after having obſerved, that all men are deſirous of living to an advanced age, but uncaſy under it when attained, he makes this juſt reflection upon their conduct: “ So great is their inconſtancy, folly, and perverſeneſs !” (*Cic. de Senect. c. 2.*)

The epiphonema is uſually expreſſive of the milder and more gentle paſſions, and is not ſo vehement and impetuous as exclamation.

EPIPHORA, (from *επιφερω*, to carry with force,) in *Surgery*. The original import of the word “ epiphora” ſeems to have been a violent determination of fluids to any part of the body. At preſent, however, all ſurgeons confine the meaning of the term to an affection, in which the tears, not being able to paſs in a proper manner down into the noſe, accumulate in front of the eye, and trickle over the cheek. The diſorder is alſo not unfrequently denominated the “ watery eye.”

Whoever is in the habit of conſulting ſurgical books, will ſoon perceive, that writers do not make a clear diſtinction between the epiphora, and ſome ſtates of the *ſiftula lachrymalis*. Thus Mr. Ware has particularly conſidered the

ſpecies of epiphora, which, he ſays, “ is produced by an obſtruction to the free paſſage of the tears from the eye into the noſe. This obſtruction (he adds) may take place either in the ducts leading from the *puncta lachrymalia* into the lachrymal ſac, or in the ſac itſelf. When the ducts are obſtructed, a caſe which rarely occurs, the tears fall over the cheek, and the ſac is conſtantly empty. Preſſure on the ſac, therefore, can produce no regurgitation, either of tears, or mucus, into the eye. The method of cure is here evident. A ſmall probe of a ſuitable ſize muſt be introduced through the *puncta* of the obſtructed ducts into the ſac, and this operation be daily repeated until the obſtruction be removed. But, (continues Mr. Ware,) the part in which the obſtruction more commonly lies, is in the ſac itſelf; and in this caſe, the tears, mixed ſometimes with mucus, flow back into the eye through the *puncta*, when preſſure is made on the ſac.” Now, this latter kind of diſeaſe, Pott, Scarpa, and other diſtinguiſhed ſurgical authors, conſider only as one ſtage of the *ſiftula lachrymalis*.

We do not mean, however, by what has been ſtated, to make any attempt to defend the manner in which the expreſſion “ *ſiftula lachrymalis*” is employed; our ſole aim is to ſhew, that, unleſs a line of diſtinction is drawn between what ſhould be called “ epiphora,” and what “ *ſiftula lachrymalis*,” the comprehension of the ſubject is rather embarrassed, than promoted, by having two different terms, which ſo glaringly encroach upon each other in the extent of their ſignification. The epiphora, in the meaning of a mere weeping of the eye, may ariſe from a variety of cauſes, which muſt be removed, ere the complaint can be cured. An encanthis, or any other kind of tumour in the inner angle of the eye, a polypus in the noſe, an ectropium, a trichiaſis, &c. may obſtruct the due flowing of the tears into the noſe, and thus make them fall over the ſubjacent cheek, ſo as to occaſion an epiphora. This latter diſorder may alſo be the conſequence of a part of the *caruncula lachrymalis* having been loſt, either by diſeaſe, or an unſkilful employment of the knife in ſome previous operation. An epiphora is always attendant on obſtructions in the *ductus naſalis*. Mr. Ware obſerves, with regard to another ſpecies of epiphora, originating from a too copious ſecretion of tears, that, if it does not depend on an affection of the mind, its more remote cauſe is uſually an inflammation of the eye. In this inſtance, a cure is to be effected by ſubduing the ophthalmia, and afterwards ſtrengthening the eye by mild aſtringent applications, ſuch as cold water, either alone, or containing a ſmall quantity of the *zincum vitriolatum*.

When the membrane, which lines the lachrymal ſac, is in a morbid ſtate, the mucus which it ſecretes is often ſo thickened, that it becomes incapable of paſſing through the ſac, and lodging in this ſituation, prevents the natural and regular deſcent of the tears from the eye into the cavity of the noſe.

This ſpecies of epiphora has occaſionally been benefited by the unguentum *hydrargyri nitrati*, applied to the edges of the eye-lids, and rubbed into the ſkin over the lachrymal ſac. Relief is alſo alleged to have been derived from the uſe of ſtimulating applications to the inſide of the noſe, which applications are ſuppoſed to have acted by increaſing the ſecretion from the pituitary membrane.

However, we muſt confeſs, that no men of experience, at the preſent day, place ſufficient reliance on the preceding methods, to recommend them to be tried by their patients. At the ſame time it ſhould be underſtood, that theſe plans are ſometimes exceedingly proper to be adopted in conjunction with other more efficacious meaſures.

## EPIPHORA.

In the year 1712, M. Anel recommended the introduction of a probe, and then the injection of a fluid, through the puncta lachrymalia, with a view of clearing away whatever matter might prevent the tears from readily finding their way through the lachrymal sac and nasal duct into the nose. M. Anel relates, that he accomplished many striking cures in this manner; and Heister confirms the efficacy of the plan, by appealing to his own practice, in which he had often produced a complete recovery in the short space of three days.

In the year 1780, sir William Blizard considered, that when water was injected through the punctum lachrymale, it not only had but very little specific weight, but was driven through the lachrymal sac in an unfavourable direction. These reflections led him to make the proposal of introducing quicksilver through a small pipe, which communicated with a long tube full of this metal. Sir William Blizard was of opinion, that the quicksilver, in consequence of its great weight, would have more power when the sac was filled with it, of removing the obstruction, than the mere injection of water. This gentleman also, in a paper read to the Royal Society, states, that he had produced a cure by the introduction of quicksilver in an example which had lasted seven months; and that the mercury passed readily through the ductus nasalis, at the third and fourth times of repeating the operation.

When the celebrated Mr. Ware was in Paris, in the year 1791, he learnt from Messieurs Grandjean and Monsieur Arrachart, eminent oculists in that city, that the plan of injecting water through the puncta lachrymalia, in incipient cases of fistula lachrymalis, was not given up in France. Mr. Ware even saw some troublesome cases cured on the continent in this way. Hence he was determined, on his return to London, to give Anel's operation a fuller trial than he had previously done. For this purpose he got Mr. Pepys, in the Poultry, to construct a small silver syringe, with pipes of different sizes adapted to it.

The following case, which afforded Mr. Ware the first opportunity of ascertaining more carefully the efficacy of Anel's treatment, is related in his own words, and will serve to inform the reader of several useful practical circumstances.

"A lady in Great Russell-street came under my care, who for many months had been subject to an epiphora of the left eye, which prevented her both from reading and working with her needle, without undergoing great inconvenience. Whenever she employed herself in any way that required close attention, her eye became overspread with tears, and the sight was so much confused, that it obliged her to leave off almost as soon as she began. A great variety of remedies had been applied, under the direction of different medical men, but none of them produced any essential amendment. On examining the eye, I observed that the tunica conjunctiva, near the inner angle of the eye-lids, was slightly inflamed; and on pressing the lachrymal sac with my finger, I perceived that a tear regurgitated through the lower punctum. This appearing to be a proper case for the use of the syringe, I immediately determined to employ it. But I found, that though a tear came through the lower punctum on my pressing the sac, yet this punctum was so small that it would not admit the point of the smallest syringe I then had. I introduced into it, however, a small probe, and by means of this I so far dilated the orifice, that it admitted the point of the syringe on the next day without any difficulty. Upon my first using the injection, the water escaped through the upper punctum almost as fast as it was introduced through the lower; but, notwithstanding

this, I persevered in urging the liquor on, until the whole contents of the syringe were exhausted. I repeated the injection three times the same day in immediate succession. The lady, however, was not sensible that any part of the water passed through the duct into the nose during either of these operations; and indeed it soon became evident that none had passed; for, having cleared her nose before I began, on her blowing it again immediately afterwards, she could produce no moisture on her handkerchief. I repeated the operation three times, both on the second and on the third day; and each day, during the time that the water was passing, I not only endeavoured to prevent it from coming through the upper punctum, by covering it with the point of my finger, but I occasionally pressed the lachrymal sac in order to give the water an inclination downward. On the fourth day I very plainly perceived, on the patient's clearing her nose after the operation, that a part of the water had passed through the duct; and, the next morning, I had the satisfaction to hear, that the eye, on the preceding day, had watered much less frequently than it had done for a considerable time previous to it. I repeated the process above-mentioned about ten times, in as many days, and I observed that the quantity of water which passed through the duct was augmented every time I used it. The tears, after this, resuming their natural course, the lady recovered the power to read and work without any inconvenience." (See Ware on the Epiphora.)

Mr. Ware, in his practice, uses common water for the injection, sometimes in a cold state, but more frequently warmed. The pipes which this gentleman employs, are also much shorter than the one represented by Mr. Benjamin Bell in his System of Surgery, (vol. iii. pl. 37). They are also a little arched towards their point. Mr. Ware thinks, that when they are made in this manner, they can be more conveniently introduced into the punctum lachrymale, than when long and straight. He recommends always having ready several pipes of different sizes, and using the largest one which can be introduced without pain. He finds it also advantageous to stand either behind the patient or on the side opposite to that of the diseased eye; and high enough to have a full command of the patient's head. Thus the operator will gain a complete view of the lower punctum, which will also be in a convenient position to receive the pipe of the syringe. Mr. Ware, moreover, advises us to remove the finger from the lower eye-lid as soon as the pipe is introduced, and to place it over the upper punctum, so as to prevent the fluid from escaping through this aperture. The same finger is likewise to be occasionally used in making pressure on the lachrymal sac, in order to aid in forcing the injection down into the nose.

Mr. Ware has published some additional remarks on the epiphora, and makes some very valuable observations on the treatment of another species of the disorder; we allude to that kind which proceeds from a thickening of the membrane which lines the lachrymal sac and duct, and a spasmodic constriction in any part of this passage, conjoined, perhaps, with a morbid secretion of thickened mucus. Mr. Ware imputes a few occasional failures, in the above simple mode of treatment, to the causes of the disease being sometimes of this nature. The following extract will explain the different methods to which this celebrated oculist has recourse in different cases.

"I in general begin the treatment by injecting some warm water through the inferior punctum lachrymale, and I repeat the operation four or five days in succession. If, in this space of time, none of the water pass through the duct

duct into the nose, and if the watering of the eye continue as troublesome as it was before the injection was employed, I usually open the angular vein, or direct a leech to be applied near the lachrymal sac; adding here a caution, that the leech be not suffered to fix on either of the eye-lids, lest it produce an extravasation of blood in the adjacent cells. About the same time that blood is taken away in the neighbourhood of the eye, I usually vary the injection, and try the effects either of a weak vitriolic, or anodyne, lotion. In some instances also, when I have found it impossible, after several attempts, to inject any part of the liquid through the duct, I have introduced a golden probe, about the size of a bristle, through the superior punctum lachrymale, and, attending to the direction of the duct, have insinuated its extremity through the obstruction, and conveyed it fully into the nose; immediately after which I have found, that a liquid, injected through the inferior punctum, has passed without any difficulty; and, by repeating these operations, for a few successive days, I have at length established the freedom of the passage, and completed the cure. In other instances, I have recommended a strongly stimulative sternutatory to be snuffed up the nose, about an hour before the time of the patient's going to rest, which, by exciting a large discharge from the schneiderian membrane, has sometimes also greatly contributed to open the obstruction in the nasal duct.

"Cases occur very rarely which may not be relieved by some of the means above related." (Ware's Additional Remarks on the Epiphora.)

When the discharge has been fetid, Mr. Ware has sometimes found, that a vitriolic lotion, injected into the sac, has quickly corrected the quality of the matter.

Scarpa, in his "Osservazioni sulle principali Malattie degli Occhi," maintains, that the chief part of the yellow viscid matter, which accumulates in the lachrymal sac, is secreted by the lining of the eye-lids, and by the little glands of Meibomius; and that the altered quality of this secretion has a principal share in the cause of the disease. He states, that the truth of this fact may at once be ascertained by everting the eye-lids; and especially the lower one of the affected side; and by comparing them with those of the opposite eye. The former will always exhibit an unnatural redness of the internal membrane, which has a villous appearance, all along the extent of the tarsus, while their edges are swollen; and numerous varicose vessels are distinguishable on its surface. The follicles of Meibomius are also turgid and prominent.

Hence, Scarpa advises making such applications to the inside of the eye-lids, as have a tendency to improve the quality of the secretion from them, at the same time, that attempts are made to remove the obstruction in the ductus nasalis. Mr. Ware, indeed, had previously noticed, that such treatment may occasionally be proper.

"When an epiphora is occasioned by an acrimonious discharge from the sebaceous glands on the edges of the eye-lids, it must be evident, that injections into the sac will be very insufficient to accomplish a cure, because the sac is not the seat of the disorder. The remedies that are employed must be directed, on the contrary, to the ciliary glands themselves, in order to correct the morbid secretion that is made by them; and for this purpose, I do not know any application that is so likely to prove effectual as the unguentum hydrargyri nitrati of the new London Dispensatory, which should be used here in the same manner in which it is applied in common cases of the psorophthalmia. It will be proper to cleanse the eye-lids every morning, from the gum that collects on the edge during the night, with

some soft unctuous application; and I usually advise to apply to them two or three times in the course of the day a lotion composed of three grains of white vitriol, in two ounces of rose, or elder-flower, water."

Mr. Ware very judiciously censures the plan of applying collyria to the eye by means of linen, wet in them; and he recommends eye-glasses for the purpose, or insinuating the fluid, between the eye and eye lids, with a camel-hair pencil, thoroughly wet in the application. (Additional Remarks on the Epiphora.)

Scarpa also extols washing the eye, three or four times a day, with a vitriolic collyrium; and, besides praising the ointment recommended by Mr. Ware, he recommends Janin's ophthalmic ointment, to be smeared over the margins and lining of the eye-lids every morning and evening.

R. Adipis. Suille. Tutia præp. Bol. Armen. ſing. ʒij. Calcis Hydrarg. alb. ʒj. Miscce. To be used at first lowered with a larger proportion of lard, than is above ordered. See FISTULA Lachrymalis.

EPIPHYLLOSPERMOUS PLANTS, of *επι, φυλλον, leaf*, and *σπέρμα, seed*, are the same with the capillaries, herbs which bear their seed on the back part of their leaves. See CAPILLARY.

EPIPHYLLUM, in *Botany*, *επι, υρον*, and *φυλλον, a leaf*, from the mode in which the flowers grow upon a flat stem resembling a leaf, see CACTUS *Phyllanthus*, sp. 40.

EPIPHYSIS, in *Anatomy*, is a name given to certain parts of bones at a particular period of their formation. See BONE.

EPIPLA'SMA, from *επι*, and *πλάσσω, to spread*, in *Surgery*, the name of an application to wounds: it consisted of wheat meal boiled in hydreæum.

EPIPLOCE, *Επιπλοκη*, in *Rhetoric*, the same with *climax*, which see.

EPIPLOCE'LE, from *επιπλον, the omentum*, and *κηλη, a tumour*, in *Surgery*, an omental hernia, or a rupture formed by a protrusion of a piece of omentum from the cavity of the abdomen.

Le Dran informs us, that in an epiplocele there is nothing to be felt, except a deughy softness, which neither absolutely yields to the touch, nor very sensibly resists it. The tumour has a flabby unequal feel; and, when there is no stricture, is perfectly indolent. It is more compressible than that arising from protruded intestine, and, when the quantity of omentum is large, the epiplocele may, in some measure, be distinguished by its weight.

As the subject of omental ruptures will be particularly considered under the head HERNIA, we shall, for the present, content ourselves with referring to the latter article.

EPIPLOIC, in *Anatomy*, a term applied to parts which belong to the epiploon, or omentum; thus we have epiploic arteries, &c.

EPIPLOOMPHALON, from *επιπλον, the omentum*, and *ομφαλος, the navel*, in *Surgery*, an omental hernia protruding at the navel.

EPIPLOON, in *Anatomy*, called also omentum or cawl, is a membranous expansion contained in the cavity of the abdomen: and continued from the peritoneal covering of some of the viscera. There are two very distinct productions, of the nature just described, distinguished by the appellations of minus and majus, from their difference in size; and by those of hepatico-gastricum, and colico-gastricum from their situation. But when the epiploon, or omentum, is spoken of generally, the greater or colico-gastric portion is understood. To the peritoneal surface of the large intestine are attached numerous small processes,

## EPIPLOON.

which resemble the epiploa in their apparent structure, and are called *appendices epiploicae*.

Although the omenta are usually represented by anatomists as processes of the peritoneum, their organization differs essentially from the structure of that membrane. Their groundwork or basis consists of the most delicate and transparent membrane of the body; which is lacerated on the application of very slight force. This membrane is composed obviously of two layers, connected by cellular tissue, and containing numerous venous and arterial ramifications. A greater or smaller quantity of fat is deposited between these layers, and in the course of the vessels. When this deposition is very considerable, as in very corpulent individuals, or in animals who have been fattened for the slaughter, the peculiarly transparent delicate appearance of the omental membrane is entirely destroyed, and the part is converted into a layer of fat. Ordinarily, however, the adipous substance is confined to the neighbourhood of the blood-vessels, accompanying them in their subdivisions, but leaving intervals in which the membrane exhibits its distinguishing diaphanous appearance. In emaciated subjects, during the period of infancy, and particularly in the foetal state, the quantity of fat is very trifling. Under such circumstances we can observe most distinctly that the deposition of fat is confined to the course of the vessels. As the omenta are entirely unconnected to the parts on which they lie, as well as to those by which they are covered, both their surfaces are smooth and glistening, and moistened like those of other serous membranes, by a serous exhalation, which facilitates their motions over the neighbouring organs. Analogy warrants us in ascribing this secretion to the arteries of the omenta; and we consequently consider these organs as an extension of the general serous surface of the abdominal cavity.

Experiments on living animals, and surgical operations, clearly prove that the membrane of the omenta possesses little, if any, sensibility in its healthy state.

The *lesser epiploon, mesogaster, omentum minus, or hepaticogastricum*, is the portion extended from the small arch of the stomach to the concave or under surface of the liver. It arises, behind, from the posterior half of the transverse fissure of the liver; on the right it is continuous with the peritoneum covering the neck of the gall-bladder and the beginning of the duodenum; towards the left it is reflected immediately from the diaphragm. Advancing from these points, in two closely united layers, towards the stomach, it is attached to the end of the oesophagus, to the whole lesser arch of the stomach, to the pylorus, and commencement of the duodenum. At this line its layers divide, and expand over the stomach, one of them forming the superior, and the other the inferior peritoneal covering of this viscus. Between the layers of the lesser omentum are contained the hepatic vessels and biliary ducts, the coronary vessels of the stomach, some branches of the coeliac plexus of nerves, and of the par vagum, and a few absorbent glands. Fat is rarely deposited here in so large a quantity as in the large epiploon, so that we can usually see through it that portion of the liver called lobulus spigelii, which is in contact with its inferior surface.

The biliary ducts, the hepatic vessels with numerous accompanying branches of nerves from the coeliac ganglia, and a considerable portion of the hepatic and cystic absorbents, connected and surrounded by adipous and cellular substance, are inclosed in the right edge of the lesser omentum. This part is called *capsula Glissoni*, from an English anatomist, who described it minutely in a work entitled "De Hepate." The very margin of the omentum is occupied by the biliary

ducts, and the neck of the gall-bladder. At this border the two surfaces of the little omentum are continuous. Behind the unconnected edge, round which the peritoneum turns, is found the foramen of Winslow, or *foramen epiploicum*, large enough to admit one or two fingers, which can thus be placed in immediate contact with the back part of the liver, and the inferior surface of the little omentum. This opening is situated between the neck of the gall-bladder, and the beginning of the duodenum, with the hepatic vessels in front, and the vena cava behind. It is not unusual to find its edges adhering together. We shall have occasion to mention it again after describing the large omentum.

The great omentum, *epiploon majus, vel gastro-colicum*, is the loose membrane, more or less loaded with fat, lying in front of the bowels, and generally meeting our eye in laying open the abdomen. It differs extremely in length and situation; in some cases reaching as low as the pelvis, and often descending in ruptures to the very bottom of the scrotum; while in others it extends but a short way below the umbilicus. It is always shorter in children than in adults. We often find it folded, or rolled on itself, and drawn to some one part of the abdomen, or tucked up over the stomach, so as to leave the small intestines exposed to our immediate view. Its natural situation between the bowels, and the parietes of the abdomen, explains the frequency of its protrusion, together with the intestines, in hernia. Some anatomists assert that it hangs lower on the left than on the right side of the abdomen.

The great omentum is a continuation of the peritoneal covering of the stomach. We have already described this as being formed by the separation of the two layers which constitute the little omentum. At the great curvature of the stomach these layers again coalesce into one sheet of membrane, are produced till they meet with the transverse arch of the colon, to inclose which they again separate. Meeting at the opposite line they once more unite, and are continued under the name of the transverse mesocolon to the root of the mesentery. The origin of the great epiploon, when minutely examined, commences in the left from the end of the oesophagus, and from the notch of the spleen (where it forms a membranous connection between this organ and the stomach) and includes the whole of the great arch of the stomach nearly as far as the pylorus. The portion of membrane thus formed descends loosely before the transverse arch of the colon, and reaches to different lengths beyond it, constituting the anterior layer, or *lamina gastrica* of the great epiploon. At the lower or floating border this membranous expansion is doubled on itself, and turning upwards again to meet the transverse arch of the colon, forms the posterior layer, or *lamina colica* of Haller. On the right side the great omentum is not only attached to the transverse portion of this intestine, but is continued along its hepatic flexure, and for some way down the ascending colon. In some instances it reaches as low as the caecum. It is this lateral extension of the great omentum which constitutes the *omentum colicum* of Haller. Each of the layers is composed of a duplicature of peritoneum, as we have before stated, containing its proper vessels, and fat, and united closely by cellular tissue. It will be evident, from our description, that the great omentum is formed by the anterior layer alone in the space between the stomach and transverse arch of the colon; below the latter it is composed of the two layers, the lamina gastrica, and the lamina colica lying in contact with each other, but having no further connection in a healthy state of the opposing surfaces.

From this disposition of the great and little epiploa,

there results, in conjunction with the inferior surface of the stomach, and the superior surface of the transverse mesocolon a membranous bag, called usually the bag of the omentum. It offers every where on the inside a continuous serous surface, where the sides of the cavity are in close contact, but not adherent. The communication between this pouch, and the general cavity of the peritoneum, is formed by the foramen of Winslow. In order to demonstrate this fact, as well as to display the bag formed by the omenta, we introduce into this opening a pipe, surrounded by some soft substance, to prevent the escape of the air. By blowing gently we are enabled to separate the layers of the great omentum, which were in contact, and give to the whole the form of a large membranous bag, intersected by vessels and bands of fat, between which the membrane rises in pouches of various sizes. The lines formed by the stomach, and transverse arch of the colon, are but faintly seen, owing to the distention of the epiploon, which appears, as it were, suspended between them. To insure the success of this experiment some conditions are necessary, which we are not always happy enough to bring together. There must be no adhesion of surfaces, no large accumulation of fat, the subject young, and the whole conducted with the greatest delicacy, as the slightest rent in the membrane is sufficient to prevent success. In the fœtus, and in young children, the laminae of the great omentum are easily separable throughout their whole extent. In adults, and more so in old persons, they are generally more or less united, so that the cavity of the omenta is confined to the space contained between the little omentum, the under surface of the stomach, and the transverse mesocolon.

The arteries of the great omentum are derived from the right and left gastro-epiploic vessels. They are in general small, and descend between the layers of the lamina gastrica, giving off branches on either side, which anastomose freely in every direction. At the lower border of the omentum the trunks turn up again to meet the transverse arch of the colon, with the arteries of which intestine they form communications. The veins accompany the arteries in their course, and join the large venous trunks which end in the vena portarum. The few nerves it possesses are derived from the hepatic, and splenic plexuses.

The *appendices epiploicæ*, or *omentula*, are principally observed on the first parts of the great intestine, being in less number on the sigmoid flexure of the colon and the rectum. They are irregularly disposed, hanging in fringes, generally unconnected with each other, sometimes united by intermediate membranous productions. They are usually dependent from the pouches of the intestine, and not from the longitudinal bands. They are obviously formed by the peritoneal covering of the intestines, united by cellular membrane, and containing a deposit of fat in almost every instance.

The use of the omenta is entirely unknown: The lesser epiploon offers a covering, and connecting medium to some nerves belonging to the stomach, and to the hepatic vessels and ducts. To the great epiploon many offices have been ascribed, none of which are satisfactorily ascertained. It varies somewhat in size according to the state of the stomach; since, when the latter is distended, it appears to enter between the layers of peritoneum forming the anterior fold, which lose in this case their form of omentum, and become the temporary covering of this organ. What may be the probable advantages of this construction it is not easy to decide. It has been supposed again to secrete a lubricating fluid from its surface, which preserves the free motion of all the chylipoietic viscera between each other. That it increases the serous surface of the abdominal cavity is evident; but in what manner this becomes an advantageous disposition is more

than we have the means of determining. The omentum colicum, and appendices epiploicæ are subject to the same observations, being similar in structure, and consequently in uses. It is certain that a considerable portion of the great omentum may be cut away, without any subsequent inconvenience to the patient, as has been frequently observed in cases of omental hernia.

An epiploon is found in all the mammalia, where it is seen under every variety of form and size: so that no inferences can be drawn from its disposition in these particulars. In all it contains more or less of fat between its membranes, the accumulation of which would appear to bear some proportion to the active, or sluggish habits of the animal. In the hibernating species during the winter, it is loaded with fat, which exists but in minute quantities during the summer. The epiploon is not found in the other classes of animals, at least there is nothing analogous to it, but a membranous production between the liver and stomach, answering to the little omentum.

**EPIPLO'SCHEOCE'LE**, from *επιπλοου*, the omentum, *σσχειον*, the scrotum, and *κκλη*, a tumour, in *Surgery*, an omental rupture, situated in the scrotum.

**EPIPOGUM**, in *Botany*, *επι*, upon and *πογον*, a beard, because the beard, or rather lip, is turned upwards. Gmel. Sib. v. 1. 11. t. 2. f. 2. is *Satyrion Epipogium* of Linnæus; *Limodorum Epipogium* of Swartz and Willdenow. See **LIMODORUM**.

**EPIPOLÆ**, in *Ancient Geography*, was originally a piece of high ground without the city of Syracuse, and afterwards so little inhabited that it is not mentioned by Cicero in his description of this city. As it was the most elevated situation, and commanded Tyche and Neapolis, it was judiciously inclosed by Dionysius I., who encompassed it with a wall nearly 4 miles in extent. Its additional defence was the fortress of Labdalon, at its bottom, on the east; and that of Euryalus, at its top, on the north. See **SYRACUSE**.

**EPIPOMPEUTICA**, in the *Ancient Music*. Vossius, in his poetical institutes, informs us, that this was a title given to songs composed and sung on occasions of great magnificence.

**EPIPOROMA**, from *επιπρωρον*, to harden, in *Surgery*, a hard tumour on a joint: a tophus.

**EPIPROSLAMBANOMINOS**, *Gr.* in the *Ancient Music*, a name given to the string or sound below proslambanominos, which word corresponds with gamut in the Guido scale.

**EPIRE**, in *Geography*, an ancient kingdom of Greece, now united with Albania, and included in that country, of which it forms the southern part, extending from Valona to Arta.

**EPIROTS**, in *Ancient Geography*. See the next article.

**EPIRUS**, a country of Greece, bounded on the east by Ætolia, on the west by the Adriatic, on the north by Thessaly and Macedon, and on the south by the Ionian sea. This was the ancient kingdom of the Æacidae, and was first called "Epirus Dodonæa," *i. e.* the continent of the Dodonæans, and afterwards Epirus, or "the continent," that being the import of the Greek word *Επειρος*. It was anciently divided into three districts or provinces; *viz.* Chaonia, Thesprotia, and Molossis; to which some authors add Cassopia, Cassiope, or Cæstrine, and Pindus. This country is said to have been first peopled by Dodanim, the son of Javan, and grandson of Japhet, or at least by some of his posterity. We find among the nations which occupied Epirus, before they were united into one people under the common name of Epirots, the Selli, who are thought to have been the

first inhabitants of Epirus, and to have ministered in the temple of Dodona, the Chaones, the Molossi, the Dolopes, the Dryopes, the Ænians, the Pelasgi, &c. The form of government which prevailed in Epirus was unquestionably monarchical, the whole country being divided into many small independent kingdoms. Homer, and other ancient writers, mention several kings who reigned here at the time of the Trojan war. But while the other Epirotic nations continued to be governed by princes of their own blood, the Molossi became subject, at an early period, to the power of Pyrrhus, a foreign prince, whose descendants were denominated Æacidæ, from Æacus, the founder of his family. Some of these petty kingdoms, in process of time, exchanged the monarchical into a republican form of government; for Thucydides informs us, that in his time the Theprotæ and Chaones were governed, not by kings, but by annual magistrates. However, the kingdom of the Molossi soon eclipsed all others; the Molossian princes having subjected the whole country, and united the several small kingdoms of which it consisted into one, known to the ancients under the name of Epirus.

Pyrrhus, the first of the Æacidæ, was the sovereign of this country at the period when regular and authentic history commences; and he is said to have distinguished himself at the siege of Troy, when his father was killed. His reign soon terminated by a premature death; for he was murdered by Orestes in the temple of Delphi, on account of his having married Hermione, the daughter of Menelaus, who had been betrothed to Orestes. He was succeeded by his son Molossus, and several other princes, whose names it is needless to record. At length Admetus was the sovereign of Epirus, when Xerxes invaded Greece. This prince, upon the defeat of the Persians, wished to enter into an alliance with the Athenians, about the year 478 or 479 B. C. The successors of Admetus were Tharymbas, who is said to have introduced the sciences into this country, and to have formed an excellent code of laws; and Alcetes, at whose death the kingdom was divided between his two sons, Neoptolemus and Arybas, the latter of whom, when his brother died, became sole sovereign of the country, and conducted the government with great prudence, equity, and moderation. He also encouraged literature by extending his patronage to those who excelled in it. His niece Olympias, of whose education he had taken great care, was married to Philip, king of Macedon, who had by her Alexander the Great. At his death, he was succeeded by Alexander, one of his nephews; who is said to have been little inferior, in courage and conduct, to his nephew Alexander the Great; but he had the misfortune to engage, on his first setting out, with nations inured to the toils of war, and no less brave than his own Epirots; whence he used to say, that the country, which he proposed to conquer, was inhabited by men, whereas the provinces his nephew Alexander went to subdue, were peopled by women only. (Aul. Gell. l. xvii. c. 21.) The immediate successors of Alexander were Æacides and Alcetes II.; and the latter was succeeded by Pyrrhus, descended by the father from Achilles, and from Hercules by the mother. (See PYRRHUS.) After two or three short reigns, Deidamia, great grand-daughter to Pyrrhus, succeeded her father Pyrrhus III. and having no issue, she gave the Epirots their liberty, who formed themselves into a republic, which was governed by magistrates annually elected in a general assembly of the whole nation. The Macedonians on one side, and the Illyrians on the other, taking advantage of the intestine divisions, which generally attend a popular government, seized on several provinces belonging to the Epirots, and annexed them to their respect-

ive crowns. The Romans, after having conquered Philip of Macedon, restored them to their ancient liberty; but they ungratefully took up arms against their benefactors, and joined Perseus; which induced the Romans to send orders to Paulus Æmilius, after the reduction of Macedon, to plunder their cities and level them with the ground. This order was punctually, though reluctantly, executed throughout the whole country in one day. One hundred and fifty thousand of the inhabitants were made slaves, and sold to the best bidder for the benefit of the republic. All the cities of Epirus, to the number of 70, were dismantled, and the chief men of the country carried to Rome, where they were tried, and most of them condemned to perpetual imprisonment. After this catastrophe, Epirus never recovered its ancient splendour. Upon the dissolution of the Achæan league, it was made part of the province of Macedon; but when Macedon became a diocese, Epirus was made a province of itself, called the province of Old Epirus, to distinguish it from New Epirus, another province lying to the east of it. On the division of the empire, it fell to the emperors of the east, and continued under them till the capture of Constantinople by the Latins, when Michael Angelus, a prince nearly related to the Greek emperor, seized on Ætolia and Epirus. He was succeeded by his brother Theodorus, who so far enlarged his dominions, that, disdaining the title of despot, he assumed that of emperor, and was crowned by Demetrius archbishop of Bulgaria. Charles, the last prince of this family, dying without lawful issue, bequeathed Epirus and Acarnania to his natural sons, who were expelled by Amurath II. Great part of Epirus was afterwards held by the noble family of the Castriots, who, though they were masters of all Albania, yet styled themselves princes of Epirus. Upon the death of the famous George Castriot, Epirus fell to the Venetians, who were soon dispossessed of it by the Turks, in whose hands it still continues; being now known by the name of Albania, which comprehends the Albania of the ancients, all Epirus, and that part of Dalmatia which is subject to the Turks. Plutarch tells us, that the Epirots enjoyed the best sort of liberty under their kings; for, as he says, a general assembly of the people was annually convened at Passaron, a city in the province of Molossis, where the king bound himself by a solemn oath to govern agreeably to the laws, and the people to obey and support him as long as he should make the laws the rule of his government.

EPISARCIDIUM, from ἐπι and σαρξ, *flesh*, a name given by many of the old authors to an anasarca.

EPISCAPHIA, from ἐπι and σκαφη, *boat*, feasts celebrated by the Rhodians.

EPISCENIA, from ἐπι and σκηνη, *tent*, feasts celebrated by the Lacedæmonians.

EPISCENIUM, Ἐπισκηνιον, in *Antiquity*, a place upon the top of the theatre, where all the machines for moving the scenes were kept. Potter. Archæol. Græc. lib. i. cap. 8. p. 42.

EPISCEPSIS, Ἐπισκεψις, an action brought to prove the diamartyria, or protestation, that the person deceased had left an heir, to be false and groundless. Potter. Archæol. Græc. lib. i. cap. 24. i. p. 128.

EPISCIRA, Ἐπισκίρα, or EPISCIROISIS, a festival celebrated at Scira in Attica, in honour of Ceres and Proserpine. Potter. Archæol. Græc. lib. ii. cap. 20. tom. i. p. 395.

EPISCHESES, from ἐπιχω, or ἐπισχω, *I restrain*, in *Medicine*, a term used by Dr. Cullen to denote the fifth order of his fourth class of diseases, which includes the retention

tention of accustomed evacuations, *viz.* constipation of the bowels, suppression of urine, of the catamenia, &c.

EPISCHION, from *επι* and *ισχιον*, *ischium*, a name given by the old Greek writers to the pubes.

EPISCOPACY, the quality of episcopal government, or that form of church discipline, wherein diocesan bishops are established, distinct from, and superior to, priests or presbyters. See BISHOP, EPISCOPAL, EPISCOPALIANS, and HIERARCHY.

Episcopacy, and presbytery, have been alternately established and abolished in Scotland.

EPISCOPACIDE, from *επισκοπος*, *bishop*, and *caedo*, *I kill*, the crime of murdering a bishop by one of his own clergy. By the ancient laws of England, the same obedience is due from a clergyman to his bishop as from a servant to his master; and therefore the offences of murdering either are made equal, that is, they are both petty treason.

EPISCOPAL, something that belongs to a bishop.

The word is formed of the Greek *επισκοπος*, *overseer*, derived from *επισκοπειν*, *inspicio*, *I inspect*, or *overlook*.

Episcopal government, is the government of a diocese, wherein one single person, legally consecrated, presides over the clergy of a whole district, in quality of head, or superintendent thereof; conferring orders, and exercising a sort of jurisdiction.

The presbyterians reject the episcopal establishment, and condemn the episcopal orders as a human institution, the mere result of secular policy, or of pride and ambition.

Among the episcopal functions, the principal part is that of holding frequent visitations of the diocese.

EPISCOPALES VALVULÆ, called also, by some, *valvulæ mitrales*, two valves in the pulmonary vein, which prevent the reflux of the blood to the heart.

EPISCOPALIA, is sometimes used in the same sense with pontificalia.

EPISCOPALIA, is also used to denote synodals, or customary payments, due to the bishops from the clergy of their diocese.

These customary payments have been otherwise called *onus episcopale*; and were remitted, by special privilege, to free churches and chapels of the king's foundation which were exempt from episcopal jurisdiction.

EPISCOPALIANS, or EPISCOPISTS, a name given to those who adhere to the church of England, and particularly to the ecclesiastical hierarchy, such as it was in the Romish church before the Reformation; who affect the discipline of bishops, priests, canons, the office, or liturgy, &c. and retain the greatest part of the canon law, with the decretals of the popes, more closely than the Catholics themselves of several countries; though, as to matters of doctrine, or faith, they agree in most points with the Calvinists, or Reformed.

In Scotland, the principal dissenters are the Episcopals; lay Episcopals enjoy all the same civil privileges with those of the established church. They are under no restrictions; tied to no tests, but are employed in all places of trust, upon taking the oaths to the government. But the episcopal ministers are liable to several penal laws; many of them having been nonjurors.

EPISCOPI MULTA. See MULTA.

EPISCOPISSA, a word used by writers of the middle ages, to denote a bishop's wife.

EPISCOPIUS, SIMON, in *Biography*, a Dutch divine of the Arminian persuasion, was born at Amsterdam in the year 1583. Having entered on his academical studies in the university of Leyden in 1600, and graduated M. A. in

1606, he pursued his theological studies with great assiduity; but on account of the disputes that subsisted between the Gomarists and Arminians, he found obstacles in the way of his admission to the ministerial office, which the burgomasters of Amsterdam wished him to assume. Disgusted by this illiberal treatment, he left Leyden in 1609, and removed to the university of Franeker, where he had to contend with similar difficulties, on account of his attachment to the Arminian doctrines. In the year 1710, however, he was admitted to the profession of the ministry, and appointed to a church at Bleswyck, in the neighbourhood of Rotterdam. In the following year he appeared as one of the deputies at the conference held at the Hague, before the states of the province, between six anti-remonstrant and six remonstrant ministers, where he distinguished himself by his defence of the opinions of his party. In 1712 he was chosen professor of divinity at Leyden, in the room of Gomarus, who surrendered that office. In this situation he conducted himself with singular prudence, as well as ability, so that he lived on terms of amity with Polyander, his colleague, who belonged to the party of Gomarists. The controversy concerning predestination was at this time the occasion of great animosity; and Episcopius, and his friends, were objects of enmity and persecution to the deluded populace. Their condition was rendered more perilous by the partisans of Maurice, prince of Orange, by whom they were calumniated, not only as heretics in their theological sentiments, but as enemies to the protestant religion, and to the United Provinces. At length Maurice and the Gomarists, of whom he was the head, succeeded in obtaining a decree of the States for convening a national synod; but the Arminians remonstrated against the meeting of such a synod, because they well know that it would be composed of their inveterate enemies, who on this occasion would appear both as their accusers and their judges. However, it met at Dort in the year 1618, (See *Synod of Dort*.) and the business of the sessions was conducted as Episcopius and his party apprehended. The ruling members were invincible, and required implicit submission to their decisions. It was in vain that Episcopius and his brethren demurred and remonstrated against their proceedings. They were expelled from the synod, and their cause was tried during their absence. The result was a sentence, which charged them with pestilential errors, and with being corrupters of the true religion. This sentence was followed by their excommunication, a deprivation of their offices, ecclesiastical and civil, a prohibition to exercise their ministry, and besides fines and imprisonment, banishment from the territories of the republic. Accordingly Episcopius, as well as several of his adherents, retired to Antwerp, where he drew up various publications in defence of his oppressed party, some of which are, "A Confession of Faith," expressed for the most part in words and phrases of scripture; a treatise, entitled "Antidotum adversus Synodi Dordracenæ Canones," and two letters, addressed to Wadingus, a Jesuit, who wished to seduce him into his church, one on the rule of faith, and the other upon the worship of images. In 1609, Episcopius withdrew into France, and endeavoured to confirm and comfort his brethren, as well as to diffuse the opinions for which he suffered, both by his correspondence and publications. In 1626, after the death of prince Maurice, and the accession of prince Frederick Henry, he returned to his native country, and enjoyed the benefits of toleration and tranquillity. The place of his settlement was Rotterdam, where he exercised his ministry for about 8 years, and composed several pieces of a theo-

logical

logical and controversial nature, which were published during his life and after his death. The Arminians, having remained for some years unmolested, established a college at Amsterdam, of which Episcopius was the first theological professor, and this appointment occasioned his removal to Amsterdam in the year 1634. In the honourable and diligent discharge of the duties of this office, he continued till his death, which happened in 1643. Episcopius was a man of solid and extensive learning; a cool and accurate judgment, a lively genius, and commanding powers of eloquence. His controversial pieces, though occasionally intermixed with unbecoming ardour and bitterness, are generally distinguished by a spirit of candour and moderation. His character was highly exemplary. His sentiments coincided with those of Arminius, which he reduced into a systematic form, and recommended by the graces of composition. His works, consisting of commentaries, theological institutions, controversial treatises, &c. form two volumes in folio; which were edited by Peter Curcellæus, who has prefixed an account of the author. A larger life of him was published by Philip à Limborch, the son of his brother's daughter, written in the Dutch language, of which a Latin version appeared at Amsterdam in 1701. 8vo. Bayle. Mosheim. Moreri. Gen. Biog.

**EPISCOPUS PUERORUM**, *bishop of the boys*, a ludicrous kind of office, formerly exercised in churches, in that called the feast of fools, or the feast of the kalends. See *Boy BISHOP*.

**EPISEMASIA**, from *επισημασιω*, *I signify*, in *Medicine*, is the very time that a disease first seizes a person, and is properly called *significatio*. Blancard.

**EPISODE**, *Επισοδιον*, from *επι*, *upon*, and *εισοδος*, *entry*, is commonly conceived to be a separate incident, story, or action, which an historian, or poet, inserts, and connects with his principal action; to furnish out the work with a greater diversity of events; though, in strictness, all the particular incidents whereof the action or narration is composed, are called episodes.

**EPISODE**, in *Dramatic Poetry*, was the second part of the ancient tragedy.

The origin and use of episodes is described by M. Hederlin, and F. Bossu. Tragedy, in its original, being only a hymn sung in honour of Bacchus, by several persons, who made a kind of chorus, or concert of music, with dancing, and the like; to diversify the representation a little, and divert the audience, they determined at length to divide the singing of the chorus into several parts, and to have something rehearsed in the intervals.

At first, a single person, or actor, was introduced, then two, then more; and what the actors thus rehearsed, or entertained the audience with, being something foreign, or additional to, or beside, the song of the chorus, and no necessary part thereof, was called *επισοδιον*, *episode*.

And hence tragedy came to consist of four parts, the prologue, episode, exode, and chorus. The prologue was all that preceded the first entrance of the chorus, and concluded with the first interlude, or choral ode, between the acts. The episode, all that was interposed between the singings of the chorus, and extended in general from the first to the last of the interludes. The exode, all that was rehearsed after the chorus had done singing, or comprehended all that was said after the last interlude. And the chorus, was the *grex*, or company, that sung the hymn. See each of these articles.

And as this recitation of the actors was in several parts, and inserted in several places, it might either be considered

together as a single episode, consisting of several parts; or each part might be called a distinct episode.

These several episodes in the same tragedy might either be taken from so many different subjects, or from the same subject divided into a proper number of recitations, or incidents.

To consider only the first occasion, and institution of these foreign or additional pieces, it appears no ways necessary, that they should be taken from one and the same subject; three or four recitations of different actions, no wise related, or connected to each other, would ease the actors, and amuse the people, in the intervals of the chorus, as well as if they were all so many parts of the same action. By degrees, what was at first only an addition to the tragedy, became the principal part thereof. Then the several pieces, or episodes, began to be considered as one single body which was not to have parts, or members of different nature, and independent of each other.

The best poets took the thing in this light, and drew all their episodes from the same action; which practice was so fully established in Aristotle's time, that he lays it down as a rule. Those tragedies wherein this unity and connexion were not observed, he called *episodic pieces*. See *TRAGEDY*.

**EPISODE**, in *Epic Poetry*. The term episode, by being transplanted from the stage to the *epopœia*, did not change its nature. All the difference Aristotle makes between the tragic and epic episodes, is, that the latter are more ample than the former.

Aristotle uses the word in three different senses: the first taken from the enumeration already made of the parts of the tragedy, *viz.* prologue, chorus, episode, and exode; whence it follows, that in tragedy, every thing is episode that is none of the other parts; so that as, among us, there are tragedies without either prologue, chorus, or epilogue, the tragic episode includes the whole tragedy; consequently the epic episode must be the whole poem, in like manner; all there is to retrench from it being the proposition and invocation, which stand in lieu of the prologue. In this sense, the *epopœia* and tragedy have each only one episode; and if the parts or accidents be ill connected together, the poem will be episodic and defective.

But farther, as all that was sung in the tragedy was called the chorus, in the singular number, yet this singularity did by no means prevent every part or division of the same from being called a chorus, without making several chorusses; so it was with the episode; each incident, and part of the fable and action, is not only a part of the episode, but it is an episode itself.

The term episode, therefore, in this sense, signifies every part of the action expressed in the plan, or first draught of the fable; as the absence and wanderings of Ulysses, the disorders in his family, and his presence, which retrieved and set all to rights again.

Aristotle furnishes us with a third kind of episode; in shewing that what is contained and expressed in the first plan of the fable is proper, and that all the rest is episode.

By *proper* he means what is absolutely necessary; and by episode, what in one sense is necessary, and in another not; so that the poet is at liberty to use, or let it alone.

Thus, Homer, having made the first draught of the fable of his *Odyssæy*, was not at liberty either to make Ulysses absent from his country, or not. His absence was essential; and therefore Aristotle ranks it among the things he calls *proper*. But he does not bestow that appellation on the adventures of Antiphates, Cice, the Sirens, Scylla, Charybdis,

Charybdis, &c. The poet was at liberty to have left these alone, and to have chosen others in their room; so that they are episodes distinct from the first action, to which they are not immediately necessary.

The third sense of the word episode comes to the second: all the difference between them is, that what we call episode in the second sense, is the ground or plan of the episode in the third; and that the third adds to the second certain circumstances which are only probable, and not necessary, as the places, princes, and people, among whom Ulysses was cast by Neptune.

It must be added, that in an episode in the third sense, the incident, or episode in the first sense, whereon it is grounded, is to be extended and amplified; otherwise, an essential part of the action and fable does not become an episode.

Lastly, it is in this third sense that we are to understand that precept of Aristotle, not to make the episodes till after the names of the persons have been chosen. Homer would not have spoken of the fleets and ships as he has done, if, in lieu of the names of Achilles, Agamemnon, and Iliad, he had chosen those of Adrastus, Capaneus, and Thebaid.

Upon the whole, the term episode, in the epic poem, as used by the father of the critics, Aristotle, does not signify any foreign or accidental adventure; but the whole narration of the poet, or a necessary and essential part of the action and subject, amplified with probable circumstances.

Thus Aristotle enjoins that the episode be not added to the action, or fetched from elsewhere; but that it be a part of the action; and never uses the word *adding*, in speaking of episodes, though it occurred so naturally to his interpreters, that they have generally used it in their translations and comments. He does not say, that after laying the plan and choosing the names, the poet is to add the episodes; but uses the derivative of the word episode, *επισοδον*, as if in English we should say epifodify his action.

From what has been said, we may venture to define episodes to be necessary parts of the action, extended and filled up with probable circumstances. Now an episode is only a part of an action, and not a whole action; and this part of the action, which is the base or ground of the episode, must not, when epifodified, retain any thing of the simplicity which it had when first expressed in general, in the plan of the fable.

The subject of a poem may be lengthened two ways; either by the poet's making use of a great many of his episodes; or by his amplifying and giving a greater extent to every one. By this latter method, chiefly, it is, that the epic poets lengthen their poems much beyond the dramatic. It must be added, that there are certain parts of an action, which of themselves do not naturally present or afford more than one episode; such as the death of Hector, of Turnus, or the like: whereas there are other parts of the fable more copious and fertile, and which oblige the poet to make diverse episodes on each, though laid down in the first plan with as much simplicity as the rest: such are the battles of the Trojans and Grecians, the absence of Ulysses; the wanderings of Æneas, &c. For Ulysses's absence so many years from his own country, required his presence elsewhere; and the design of the fable was to throw him into several dangers, and different countries. Now each peril, and each new country, furnished an episode, which the poet might use if he pleased.

The result of the whole is, that episodes are not actions, but parts of actions; that they are not added to the action and matter of the poem, but make the action and matter

themselves; that of course they are not to be fetched from elsewhere, but raised from the ground or basis of the action; that they are not united and connected with the action, but with one another; that all the parts of an action are not so many episodes, but only such as are amplified, and attended with particular circumstances; and lastly, that their union with each other is necessary in the ground of the episode, and probable in the circumstances.

Episodes, says Dr. Blair, (Lectures. vol. iii.), as the term is now understood, are certain actions, or incidents, introduced into the narration, connected with the principal action, yet not of such importance as to destroy, if they had been omitted, the main subject of the poem. Of this nature are the interview of Hector with Andromache, in the Iliad; the story of Cacus, and that of Nisus and Euryalus in the Æneid; the Adventures of Tancred with Erminia and Clorinda, in the Jerusalem; and the prospect of his descendants exhibited to Adam, in the last books of Paradise Lost. Such episodes as these, are not only permitted to the epic poet; but, provided that they be properly executed, are great ornaments to his work. The rules that serve to regulate them are such as follow: they must be naturally introduced, and have a sufficient connection with the subject of the poem; they must seem to be inferior parts belonging to it, and not mere appendages annexed to it. In the next place, episodes ought to present to us objects of a different kind, from those which go before, and those which follow, in the course of the poem. For episodes are introduced into an epic composition, principally for the sake of variety. Lastly, as an episode is a professed embellishment, it ought to be particularly elegant and well-finished; and, accordingly, it is, for the most part, in pieces of this kind, that poets put forth their strength. The episodes of Taribezus and Ariana, in Glover's Leonidas; and of the death of Hercules, in the Epigoniad, are the two greatest beauties in these poems. With regard to episodes in didactic poetry; see DIDACTIC Poetry.

EPISODIC, in Poetry. A fable is said to be epifodic, when it is swelled with unnecessary incidents; and its episodes are not necessarily, nor properly, connected with each other.

Aristotle lays it down, that those tragedies are most defective, whose episodes have no connection, or dependence on each other, which he calls epifodic, *q. d.* superabundant in episodes; because so many little episodes can never compose one whole one, but necessarily remain in a vicious plurality.

If an episode be used, the names and circumstances whereof are unnecessary, and whose ground and subject make no part of the action, that is, of the matter of the poem, such an episode renders the fable epifodic. This irregularity is discovered, when one may take away a whole episode, without substituting any thing in its room; and yet leave no chasm, or defect, in the poem. The history of Hyppisule, in Statius's Thebaid, affords an instance of these faulty episodes. If the whole story of that illustrious nurse were retrenched, the sequel of the principal action would be the better for it. Nor would any body imagine he had forgot any thing, or that there was any member of his action wanting. Bossu, and Arist. Poet. cap. 9.

EPISPASTIC, from *επι* and *σπάω*, *I draw*, in Medicine, a term denoting the quality of those substances, which, when applied to the skin, draw the humours to the part, or excite inflammation and vesication in it. The word, therefore, is nearly synonymous with vesicatory, or blistering. See BLISTER.

**EPISPHERIA**, from *σφαῖρα* and *σφαιρα*, a sphere, in *Anatomy*, are windings and turnings in the outer substance of the brain, that the sanguiferous vessels may pass more securely.

**EPISTÆBE**, in *Botany*, a name given to the cuscuta or dodder, found growing on the plant stæbe of the ancient Greeks. See **ΕΠΙΦΥΕΙΟΣ**.

**EPISTAPHYLINUS**, in *Anatomy*, a name under which the azygos uvulæ muscle has been described. It will be found, in different writers, under the names of staphylinus, columellæ musculus teres, musculus uvulæ, or muscle de la luette. It is described in the article **DECLUTITION**.

**EPISTATES**, *Επιστάτης*, derived from *επι*, over, and *στημι*, I stand, in *Antiquity*, a person who has the command and direction of an affair, or of a people.

The term is of considerable use, in speaking of the government of Athens, where the epistates was the senator in command for that day, or whose turn it was to preside that day. The constitution was this: the ten tribes of Athens formed by Clithenes, elected every year by lot, each of them, fifty senators, which made a senate of five hundred. Every tribe had the precedence in its turn, and surrendered it again successively to another. The fifty senators in office were called prytanes; the particular place where they assembled, prytaneum, and the term, or duration of their office, viz. thirty-five days, prytanea. During these thirty-five days, ten of the fifty prytanes presided weekly, under the name of proedri; and of these proedri there was one to preside each day of the week, under the title of epistates.

No person was allowed to hold his office more than once in his whole life, lest he should acquire too much the taste of dominion: the senators of all the other tribes still voted, according to the order the lot had given them; but the prytanes laid the business before them, and the epistates took their votes and opinions.

It must be added, that of the ten proedri, of each week, there were but seven that would preside each his day in the quality of epistates; the ten proedri elected the seven prytanes.

**EPISTA'XIS**, from *επιστάζω*, *insillio*, in *Surgery*, hemorrhage from the nose.

When bleeding from the nose takes place in such a degree as to be dangerous, or likely to bring on excessive debility, the further effusion of blood may be stopped in the following manner. Roll a considerable piece of lint round the end of a probe; wet it completely through with a strong solution of the zincum vitriolatum; introduce it into the nostril, and press it as strongly as possible against the part whence the blood issues. As soon as the blood ceases to flow, we may conclude that the pressure acts on the bleeding point. This plan generally succeeds.

When the blood, however, flows from some point which lies very deeply in the nostril, it might be found impracticable to make pressure exactly on the bleeding vessels. At all events, we may then pass a piece of catgut through the nostril, and bring it out of the mouth, from the fauces, by means of a pair of common forceps. A tent of lint may next be fastened to the ligature, and drawn backward through the mouth into the nose, so as completely to stop up the posterior opening of the nostril. The front aperture may be easily filled with a proper dossil of lint. In this manner, it is clear that no further hemorrhage can happen, as the blood cannot possibly find its way outward.

**EPISTEMONARCH**, derived from *επιστημοναρχος*, *know-ledge*, and *αρχη*, command, a dignitary, in the *Ancient Greek Church*, appointed to watch over the actions of the church,

and to inspect or superintend every thing relating to the faith, in quality of a censor. His office answered pretty much to that of magister sacri palatii at Rome.

**EPISTHOTONOS**, from *επισθω*, forwards, and *τυνα*, to extend, in *Surgery*, a species of tetanus, in which the body is bent forwards. See **TETANUS**.

**EPISTITES**, from *επιστημι*, I keep off, in *Natural History*, the name of a stone, described by the writers of the middle ages, as being of a beautiful red, and shining very elegantly. It was renowned for its many magical virtues, according to the idle tradition of these times; they said it drove away all noxious animals, and kept off storms from the place where any one was who had it about him.

**EPISTLE**, a letter missive.

The word is formed of *επιστηλλω*, I send.

The term epistle is now scarcely used, but for letters wrote in verse, and letters dedicatory.

In speaking of letters written by moderns, or rather in the modern languages, we never use the word epistle. Thus, we say, the letters, not epistles of the cardinal D'Osiat, of Voiture, of Balzac, of Howel, of Pope, &c.: but those wrote by the ancients, or rather in the ancient language, we call epistles; as the epistles, not letters in Cicero, Pliny, Seneca. The epistles of St. Paul, St. Peter, St. John, &c. to the Romans, Corinthians, &c.

A Table of St. Paul's Epistles, in the order of time, with the places where, and the times when they were written.

Epistles.	Places.	A. D.
1 Thessalonians	Corinth	52
2 Thessalonians		
Galatians	Corinth, or Ephesus	Near the end of 52 or the beginning of 53
1 Corinthians	Ephesus	
1 Timothy	Macedonia	The beginning of 56
Titus	Macedonia, or near it	Before the end of 56
2 Corinthians	Macedonia	About October 57
Romans	Corinth	About February 58
Ephesians	Rome	About April 61
2 Timothy	Rome	About May 61
Philippians	Rome	Before the end of 62
Colossians	Rome	Before the end of 62
Philemon	Rome	Before the end of 62
Hebrews	Rome, or Italy	In the spring of 63

A Table of the Seven Catholic Epistles, so called because they were written to Christians in general, and the Revelation, with the places where, and the times when they were written.

Epistles.	Places.	A. D.
The Epistle of St. James	Judea	61 or beginning of 62
The 2 Epistles of St. Peter	Rome	64
St. John's 1st Epistle	Ephesus	About 80
His 2d and 3d Epistles	Ephesus	Between 80 and 90
The Epistle of St. Jude	Unknown	60 or 65
The Revelation of St. John	Patmos, or Ephesus	95 or 96

See Lardner's Credibility of the Gospel History, vol. xvi. and vol. xvii.

Learned writers are not absolutely agreed as to the dates of these several epistles, nor the places whence they were written. It would lead us too far to examine and produce the various authorities and arguments that have been used for settling these particulars: we shall only mention that Dr. Doddridge dates the 1st Epistle to the Corinthians

about the year 57; and the 2d Epistle in 58; those to the Ephesians, Philippians, Colossians, and Philemon, in 63; the 1st to Timothy, in 58 or 65; the 2d to Timothy, in 66 or 67; the Epistle to Titus, between St. Paul's first and second imprisonment at Rome; the Epistle of St. James, in 60 or 61; the 1st of Peter in 61; the 2d, in 67; that of St. Jude, some time after the 2d of Peter, according to Dr. Mills, in the year 90. As to the general design of these several epistles, it is observed by Dr. Doddridge, who is deservedly esteemed an excellent and useful expositor, that the Epistle to the Romans is intended to fix in the minds of the Christians, to whom it is addressed, a just sense of the excellency of the gospel, and to engage them to act in a manner agreeable to their profession of it: the Epistles to the Corinthians are designed to resolve some important queries proposed by them, and to correct the various criminal irregularities and disorders, of which they were guilty: the principal design of the Epistle to the Galatians was to assert and vindicate the apostle's authority and doctrine, and to confirm the churches of Galatia in the faith of Christ, especially with respect to the important point of justification; to expose the errors that were introduced among them, and to revive those principles of Christianity which he had already taught them. In the Epistle to the Ephesians, that apostle endeavours to establish them in the faith; and to this end to give them more exalted views of the divine love and the excellence of Christ; to shew them that they were now, though Gentiles, made partakers of equal privileges with the Jews; to encourage them, by his own example and concern for their welfare; and to engage them to the practice of duties becoming their Christian character. The Epistle to the Philippians is designed to comfort them under the concern they felt on his account; to check a party-spirit that had broke out among them, and to promote union and affection; to guard them against the seduction of judaizing teachers; to support them under their trials, and to inspire them with an ambition of excelling in ornamental and distinguished attainments. The Epistle to the Colossians is designed to excite them to a temper and conduct worthy of their sacred character, and to secure them from the influence of those Pagan sophists or Jewish bigots, who endeavoured to seduce them from the purity of the Christian faith. The two Epistles to the Thessalonians are intended to confirm them in their adherence to the Christian faith, and to engage them, from the sufferings they had already endured, and the extraordinary character they had hitherto maintained, to make great advances, and to excel still more in religion and virtue; and also to rectify some erroneous apprehensions they entertained about the coming of Christ, and to direct them in the proper exercise of Christian discipline. The first Epistle of Timothy was partly intended to direct him in managing the affairs of the church, and choosing proper persons for the various offices it required; and partly to caution him against the influence of judaizing teachers, to urge him to pay a constant regard to the interests of practical religion, and to animate him to diligence, fidelity, and zeal. The second epistle prepares Timothy for the sufferings that awaited him, forewarns him of the apostacy that was beginning to appear in the church, and animates him to the persevering discharge of every part of the ministerial office. The Epistle to Titus contains a variety of prudent instructions and cautions. The design of the Epistle to the Hebrews was to confirm the Jewish Christians in the faith and practice of the gospel, which they might be in danger of deserting through the insinuation or ill-treatment of their persecutors. St. James, in his epistle, aims to correct these errors both in doctrine and

practice into which the Jewish Christians had fallen, which might otherwise have produced fatal consequences; and then to establish the faith, and animate the hope of sincere believers under their present and approaching sufferings. The Epistles of St. Peter are designed to induce the Christian converts in various parts of the world to maintain a conduct inoffensive and amiable; to support them under their trials, and to encourage their constancy, notwithstanding the artifices of false teachers, and the persecution of their most inveterate enemies. The leading design of St. John in his first epistle, is to evince the vanity of faith separate from morality; to inspire the minds of Christians with mutual charity, and to guard them against the snares and efforts of Antichrist, and of all who were endued with his spirit. The Epistle of Jude describes the characters of the false teachers, represents the divine judgments which such persons had reason to expect, and thus cautions Christians against being perverted by them. See Doddridge's Fam. Expositor, vol. iv. v. and vi. in the general introduction prefixed to each epistle. See also an account of the writers of these epistles, and of the churches to which they were addressed.

EPISTLE, *Poetical*, a species of didactic poetry, the subjects of which are the manners and characters that occur in ordinary life, and that require to be treated with somewhat of the ease and freedom of conversation. When these epistles are employed on moral and critical subjects, they seldom rise into a higher strain of poetry than *satires*, which see. Many other subjects may be discussed in the form of an epistle; such as love poetry, or elegiac; specimens of which occur in Ovid's "*Epistolæ Heroidum*," and his "*Epistolæ de Ponto*." As these works are designed to be merely sentimental, and their merit consists in being proper expressions of the passion or sentiment which forms the subject, they may assume any tone of poetry that is suited to it. But didactic epistles seldom admit of much elevation. The poet, commonly restricting himself to observations on authors, or on life and characters, and not intending to compose a formal treatise, or to confine himself strictly to regular method, gives scope to his genius on some particular theme, which, at the time, has prompted him to write. Much of the grace of this kind of writing consists in a spirited conciseness, which gives to such composition an edge and liveliness, that strike the fancy and keep attention awake. Much of their merit depends also on just and happy representations of characters. Unsupported by those high beauties of descriptive and poetical language, which adorn other compositions, the reader expects them to entertain him with lively paintings of men and manners; and therefore in these a certain sprightliness and turn of wit find their proper place, and contribute to the beauty and effect. Of this kind of poetry Mr. Pope's ethical epistles furnish an almost perfect model. In these his wit discovers itself to such a degree as to give a proper seasoning to grave reflections. His paintings of characters are natural and lively; and, never was any writer so happy in that concise spirited style, which gives animation to satires and epistles. His rhyme likewise adds to the style an elevation which otherwise it could not have possessed, while at the same time he manages it so artfully, that it never appears in the least to incumber him, but, on the contrary, serves to increase the liveliness of his manner. In this species of writing, ease and elegance are the distinguishing characters; nothing, therefore, should be forced or unnatural, laboured or affected, but every part of the composition should manifest an easy, polite, and unconstrained freedom.

EPISTOLARES, among the Romans, under-secretaries.

ries to the "magister scrinii epistolarum," or secretary who wrote the emperor's letters. They were thirty-four in number. See **MAGISTER**.

**EPISTOLARY**, a term used in the phrase epistolary style. As the matter of an epistle is the same with that of conversation, it should not differ in the manner of expression; and, therefore, all pomp and study of language are not only needless but very improper: the most plain and easy way of conveying our thoughts must certainly be best, as being most natural. Purity in the choice of words, and justness of construction, joined with perspicuity, are the chief properties of this style: to which purpose Cicero observes, "that in writing letters we make use of common words and expressions." (Ad Fam. lib. ix. cap. 21.) And Seneca says, "I would have my letters be like my discourses, when we either sit or walk together, unstudied and easy." (Ep. 75. ad Lucill.)

The first and fundamental requisite in epistolary writing is to be natural and simple, for a stiff and laboured manner is as bad in a letter as in conversation. This does not banish sprightliness and wit. These are graceful in letters as well as in conversation; when they flow easily, and without being studied; when employed so as to season, and not to clog. A person, who either in conversation or in letters affects to shine and sparkle always, will not please long. The style of letters should be neat and correct, but not too highly polished. Nicety about words betrays study; and on this account musical periods, and appearances of number and harmony in arrangement, should be carefully avoided in letters. Those that are written with the greatest facility are commonly the best. Nevertheless, it should be remembered, that the ease and simplicity of epistolary writing are not to be understood as importing entire carelessness. In writing to the most intimate friend, a certain degree of attention, both to the subject and the style, is requisite and becoming. The first requisite both in conversation and correspondence, is to regard all the proper decorums, which our own character, and that of others demand. An imprudent expression in conversation may be forgotten and pass away; but with the pen in hand, we should remember the well-known adage, "Litera scripta manet."

As the subjects of epistles are various, they will necessarily acquire some variety in the manner of expression. If the subject be weighty and momentous, the language should be strong and solemn; in things of a lower nature, more free and easy; and upon lighter matters, jocose and pleasant. In exhortations, it ought to be lively and vigorous; in consolations, kind and compassionate; and in advising, grave and serious. In narratives, it should be clear and distinct; in requests, modest; in commendations, friendly, without adulation; in prosperity, cheerful; and mournful, in adversity. In a word, the style ought to be accommodated to the particular nature of the subject about which it is conversant. Although there should be nothing very considerable in the subject; yet if the spirit and turn of the correspondence be agreeable, if the letters be written in a sprightly manner, and with native grace and ease, they may still be entertaining, more especially if there be any thing to interest us in the characters of those who write them. As letters from one friend to another make the nearest approach to conversation, we may expect to see more of character displayed in these than in other productions, which are studied for public view. We are pleased with beholding a writer so situated as to allow him to be at his ease, and to give occasional vent to the overflowings of his heart. Besides, the different character of the person, to whom the letter is written, requires a like difference in the modes of expres-

sion. Superiors should be addressed with respect; inferiors, with courtesy; and equals, with civility. Old men and young, the grave and facetious, courtiers and philosophers, friends and strangers, require some variety in the mode of address. The epistles of Cicero, the style of which is plain and simple, and yet pleasant and engaging, furnish a proper model in this respect. They are the most valuable collection of letters in any language, as they are letters of real business, written to the greatest men of the age, composed with purity and elegance, but without the least affectation; and, what adds greatly to their merit, written without any intention of being published to the world. Pliny's letters are elegant and polite; and exhibit a very pleasing and amiable view of the author; but, according to the vulgar phrase, they smell too much of the lamp. They are too elegant and fine: and the author seems to be casting an eye towards the public, when he is appearing to write only to his friends. His style abounds so much with turns and quibbles upon the sound of words, as to render it more stiff and affected than agrees with conversation, or than a man of sense would choose to use in discourse, if it were in his power. This, indeed, was owing to the age in which he lived, at which time the Roman eloquence was sunk into puns, and an affectation of wit; for Pliny was otherwise a man of fine sense and great learning. We need not here recommend Melmoth's translation of the letters of Cicero and Pliny. The most distinguished collection of letters in the English language is that of Mr. Pope, Dean Swift, and their friends; published partly in Mr. Pope's works, and partly in those of Dean Swift. Many letters in this collection are written with ease and a beautiful simplicity. Those of Dr. Arbuthnot deserve this commendation. Dean Swift's are unaffected. Several of lord Bolingbroke's and of bishop Atterbury's letters are masterly. Mr. Pope's are too artificial. Among the French in the last age, Balzac and Voiture were the two most celebrated epistolary writers. Balzac's periods are swelling, and his style pompous; so that his reputation soon declined. Voiture continued for a long time a favourite author. His composition is extremely sparkling; he manifests much wit, and trifles agreeably. His only fault is, that he is too open and professed a wit, to be thoroughly agreeable as a letter-writer. The letters of Madam de Sevigné are now esteemed the most accomplished model of a familiar correspondence. Trifling as are their subjects, and overloaded as they are with compliments, they shew such perpetual sprightliness, they contain such easy and varied narration, and so many strokes of the most lively and beautiful painting, perfectly free from any affectation, that they are justly entitled to high praise. The letters of lady Mary Wortley Montague possess much of the French ease and vivacity, and retain more the character of agreeable epistolary style, than perhaps any letters which have appeared in the English language. Ward's Orat. vol. ii. p. 213, &c. Blair's Lect. vol. iii. Lect. 37. See **STYLE**.

**EPISTOLARY** is sometimes also applied to authors who have wrote epistles or letters. The principal epistolary authors are Sidonius Apollinaris, Tully, the younger Pliny, Seneca the philosopher, Petrarch, Politian, Busbequius, Erasmus, Lipsius, Muretus, Ascham, Milton, Petau, Launci, Sarau, Balzac, Voiture, sir W. Temple, Lyttelton, &c. &c. See the preceding Article.

**EPISTOMIA**, in *Anatomy*, are the utmost gapings and meetings of vessels.

**EPISTOMIUM**, *Επιστομιον*, from *επι*, upon, and *στομα*, mouth, in *Hydraulics*, a plug or instrument, by the application whereof

whereof the orifice of a vessel may be opened and shut again at pleasure.

EPISTROPHE, *Ἐπιστροφή*, in *Rhetoric*, a figure wherein that which is supposed of one thing is strongly affirmed of another, and the repetition of the same word occurs at the end of each member or sentence:

"Since concord was lost, friendship was lost, fidelity was lost, liberty was lost, all was lost." *Auct. ad Herenn. lib. iv. cap. 13.* See also 2 *Cor. xi. 22.*

EPISTROPHEUS, in *Anatomy*, from *ἔπι*, upon, and *στρέφω*, I turn, a name given to the second vertebra of the neck, round a particular process of which the first vertebra turns. See *SPINE*.

EPISTYLE, *Ἐπιστύλιον*, from *ἔπι*, upon, and *στυλοῦς*, column, in the *Ancient Architecture*, a term used by the Greeks for what we call architrave, viz. a massive stone, or a piece of wood, laid immediately over the capital of a column.

The epistyle is the first or lowest member of the entablature.

EPITAPH, *Ἐπιτάφιος*, from *ἔπι*, upon, and *τάφος*, sepulchre; a monumental inscription, in honour or memory of a person defunct; or an inscription engraven or cut on a tomb, to mark the time of a person's decease, his name, family, and usually some eulogy of his virtues or good qualities.

At Sparta, epitaphs were only allowed to people who died in battle. Boxhornius has made a collection of epitaphs, not very ample, but exceedingly well chosen. F. Labbe has likewise given a collection of the like kind in French, intitled, "Tresor des Epitaphes." Camden, Weaver, and Toldervy, have done something in the same way with our English epitaphs.

In epitaphs, the dead person is sometimes introduced by way of prosopopœia, speaking to the living; of which we have a fine instance, worthy the Augustan age, wherein the dead wife thus bespeaks her surviving husband,

"Immatura peri: sed tu, felicior, annos  
Vive tuos, conjux optime, vive meos."

The French have a proverb, "Menteur comme une epitaphe: He lies like an epitaph;" an allusion to the eulogies ordinarily contained therein, which are not always over-just.

EPITAPH, is also applied to certain eulogies, either in prose or in verse, composed without any intent to be engraven on tombs.

The elegance of an epitaph consists in a nervous and expressive brevity, and it is sometimes closed with an epigrammatic point. It is observed by Dr. Johnson, in his life of Pope, that the difficulty of writing an epitaph consists, in giving a particular and appropriate praise. This, he says, is not always to be performed, whatever be the diligence or ability of the writer; for the greater part of mankind have no character at all, or little that distinguishes them from others equally good or bad; and, therefore, nothing can be said of them, which may not with equal propriety be applied to a thousand more.

In the *Anthologies*, or collections of epigrams, we have abundance of epitaphs, some of them ludicrous and satirical, others grave. For a specimen, we shall here add a very beautiful one, composed by Mr. Cowley, on himself, to be put in a little country-house, whither he retreated from the court and town to spend his last days.

"Hic, O viator, sub lare parvulo,  
Conleius hic est conditus, hic jacet  
Defunctus humani laboris  
Sorte, supervacuaque vita;

Non indecora pauperie nitens,  
Et non inertis nobilis otio,  
Vanoque dilectis popello,  
Divitiis, animosus hostis.  
Possis ut illum dicere mortuum,  
En terra jam nunc quantula sufficit  
Exempta sit curis, viator,  
Terra sit illa levis, precare.  
Hinc sparge flores, sparge breves rosas;  
Nam vita gaudet mortua floribus;  
Herbilque odoratis corona  
Vatis adhuc cinerem calentem."

The following epitaphs, besides many others, are worth recording. That of Alexander:

"Sufficit huic tumulus, cui non sufficeret orbis."

That of Newton:

"Isaacum Newton  
Quem immortalem  
Testantur Tempus, Natura, Cælum,  
Mortalem hoc marmor  
Fatetur."

That of Dryden:

"Dryden."

Similar to which is that which the Italians have annexed to the tomb of Tasso:

"Les os du Tasse."

The following epitaph on the sister of sir Philip Sidney, the countess of Pembroke, and said to be written by the famous Ben Jonson, is distinguished by its admirable conclusion:

"Underneath this noble marble hearse  
Lies the subject of all verse,  
Sidney's sister, Pembroke's mother;  
Death, ere thou hast kill'd another  
Fair, and learn'd, and good as she,  
Time shall throw a dart at thee."

The following also by the same author is well known, and has been much admired:

"Underneath this stone doth lie  
As much virtue as could die;  
Which, when alive, did vigour give  
To as much beauty as could live."

Another epitaph, by Dr. Samuel Johnson, on a celebrated musician, deserves to be recorded, as it is equalled by few, and surpassed by none.

"Philips! whose touch harmonious could remove  
The pangs of guilty pow'r and hapless love,  
Rest here, distressed by poverty no more;  
Find here that calm thou gav'st so oft before;  
Sleep undisturb'd within this peaceful shrine,  
'Till angels wake thee with a note like thine."

The following epitaphs are specimens of the satirical or ludicrous kind:

Prior on himself, ridiculing the folly of those who value themselves on their pedigree.

"Nobles and heralds, by your leave,  
Here lie the bones of Matthew Prior,  
The son of Adam and of Eve;  
Let Bourbon or Nassau go higher."

On a Miser.

"Reader, beware of immod'rate love of self;  
Here lies the worst of thieves, who robb'd himself."

A similar epitaph by Dr. Swift.

"Beneath this verdant hillock lies  
Damer, the wealthy and the wise.  
His heirs, that he might safely rest,  
Have put his carcase in a chest;  
The very chest, in which, they say,  
His other self, his money, lay.  
And if his heirs continue kind  
To that dear self he left behind,  
I dare believe that four in five  
Will think his better half alive."

We shall here subjoin the epitaph of the ingenious and laborious author of the Cyclopædia, from his tomb in the cloisters of Westminster Abbey, on the north side, written by himself:

"Multis pervulgatus,  
Paucis notus;  
Qui vitam inter lucem et umbram,  
Nec eruditus, nec idiota,  
Literis deditus transegit; set ut homo  
Qui humana nihil a se alienum putat,  
Vita simul et laboribus functus,  
Hic requiescere voluit  
EPHRAIM CHAMBERS,  
R. S. S.  
Obiit 15 Maij, 1740."

In English thus:

"Heard of by many,  
Known to few;  
Who led a life between fame and obscurity;  
Neither abounding, nor deficient in learning;  
Devoted to study; but as a man  
Who thinks himself bound to all offices of humanity;  
Having finished his life and labour together,  
Here desires to rest.  
EPHRAIM CHAMBERS."

We shall close this article with some pertinent remarks on epitaphs, by an anonymous writer in the "Olla Podrida." The perusal of epitaphs is not to be considered as a light and frivolous amusement. If such only be the object of attention, as have been noticed with our applause, it is unquestionably an introduction to pleasing knowledge, and an incentive to moral improvement. What biography is to history, an epitaph is to biography. It is a sketch which marks the great outlines of character, and excites curiosity to view the portraits as painted in the pages of history. It is likewise an epitome of a sermon, which teaches the most useful truths in the most comprehensive form. Monumental inscriptions remind us, that time is on the wing, that every rank and age must fall a prey to his depredations; that the moments of life are too precious to be squandered away on trifles; that religion is the only support against the horrors of death, and the only guide to the joys of eternity.

EPITASIS, formed of *επιτενω*, *intendo*, I heighten, in the *Ancient Poetry*, denoted the second part or division of a dramatic poem, wherein the plot or action proposed and entered upon in the first part or protasis was carried on, heightened, warmed, and worked up, till it arrives at its state or height called the catastasis.

This division is laid aside in the modern drama; in lieu whereof our plays are divided into acts. See ACT.

The epitasis might ordinarily take up about our second or third act.

EPITASIS, in *Medicine*, denotes the increase or growth and heightening of a disease; or the beginning of a paroxysm, particularly in a fever.

EPITHALAMIUM, *Επιθαλαμιος*, formed of *επι*, and *θαλαμος*, *bride-chamber*, in *Poetry*, a nuptial-song, or a composition, usually in verse, on occasion of a marriage between two persons of eminence.

The topics it chiefly insists on are the praises of matrimony, and of the married couple, with the pomp and order of the marriage solemnity; it concludes with prayers to the gods for their prosperity, their happy offspring, &c. This kind of poetry is very ancient: the 44th Psalm, and the book of Canticles have been considered as specimens of the epithalamium. Stefichorus, who flourished in the forty-second Olympiad, has been usually esteemed the inventor of the epithalamium among the Greeks, though it is known that Hesiod composed the epithalamium of Thetis and Peleus, a work now lost; but a fragment of which is preserved by an ancient scholiast. Catullus exceeded all antiquity in his epithalamium, and the cavalier Marino all the moderns.

Among the Greeks, the epithalamium was sung by young men and maids at the door of the bed-chamber of the married pair in the evening and morning. The former sort were called *επιθαλαμια κομητικα*, and the latter *εγερτικα*.

EPITHEM, EPITHEMA, from *επι*, upon, and *τιθημι*, *pono*, I put, in *Pharmacy*, a kind of fomentation or remedy of a spirituous or aromatic kind, applied externally to the regions of the heart, liver, &c. to strengthen and comfort the same, or to correct some intemperature thereof.

There are principally three kinds of these external applications, the liquid, the solid, and the soft or poultice kind. See CATAPLASM and FOMENTATION.

EPITHEM, *Volatile, epithema volatile*, a form of medicine prescribed in the late London Pharmacopœia, and ordered to be made of equal weights of common turpentine and spirit of sal armoniac. The turpentine is to be kept continually stirring in a mortar, and the spirit gradually dropt in till the whole is reduced to a white mass.

The spirit of sal armoniac used in this mixture must not be that made in the common way, with the addition of quick-lime, but with the alkali salt. Pemberton's Lond. Disp. p. 377.

EPITHE'SIS, from *επι* and *τιθημι*, *to lay upon*, an old-term in *Surgery*, the meaning of which was the straightening of deformed limbs by mechanical contrivances.

EPITHET, *Επιθετος*, a noun adjective, expressing some quality of a substantive to which it is joined.

The word is formed of *επι*, upon, and *θετω*, *posito*, putting. As a fruitful vine, a stately pile, an echoing vault, &c.

Epithets are of great use and conveniency among poets and orators, who supply in epithets what they want in other requisites. Card. Perron even blames Homer on the head of epithets, observing, that he frequently hooks in epithets without any sense or significancy at all, to help out his measures; and that he equips every hero with an epithet, not according to the exigence of the case, but the measure of the verse.

EPITHEM, is also used for a surname, or a person's second appellation.

Epithets were anciently bestowed very frankly, either on account of excellencies or defects of the body or mind; kings themselves were not exempted from them. Hence these

those epithets so frequent in history, as Edward Long-shanks, Richard Cœur de Leon, Edmund Iron-side, Richard Crook-back, John Lack-land, &c.

Nor have the French used their kings any better; witness their Charles the Simple, Louis the Lazy, faintant (Ludovicus nihil faciens) Pepin the Short, Louis the Stammerer, le begue.

EPITHRICADIA, in *Antiquity*, a festival in honour of Apollo.

EPITHYME. See DODDER, and EPITHEOS.

EPITOME, an abridgment, or a reduction of the principal matters of a larger book into a little compass. See ABRIDGMENT.

The word is Greek, ἐπιτομή, formed of ἐπιτέμνω, *rescere*, to retrench, abridge, or cut off.

The epitome of Baronius's Annals is done by De Sponde (Spondanus). Bernier has given an epitome of the philosophy of Gassendus.

It is a popular objection against the epitomizing of authors, that it frequently occasions the loss of the originals. Thus the loss of the historian Trogus Pompeius is attributed to his epitomizer Justin, and the loss of a great part of Livy to Luc. Florus. See LIVY.

"Epitomes," says the learned Bacon, "are the moths and corruptions of history, that have fretted and corroded the sound bodies of many excellent histories, and wrought them into base and unprofitable dregs."

EPITRITES, from ἐπι, and τρις; *third*, in *Prosody*, a foot consisting of four syllables, three long, and one short.

Grammarians reckon four species of epitrites; the first, consisting of an iambus and spondee, as *salūtāntēs*; the second, of a trochee and spondee, as *cōncitātī*; the third, of a spondee and an iambus, as *cōmmūnicāns*; and the fourth, of a spondee and trochee, as *incāntārē*.

EPITRITES, among the *Greek Musicians*, denoted a ratio, called also the sesquiquartal ratio, the same with that of three to four. See FOURTH.

EPITROCHASMUS, in *Rhetoric*, a figure wherein we slightly pass over several things of great moment, by only mentioning them in general. Such is the saying of Cæsar, *Veni, vidi, vici*.

EPITROPE. See CONCESSION. This is one of the figures of sentences, which grants one thing to obtain another more advantageous. It is either real or feigned; and either the whole of a thing, or only a part is granted. Nothing more confounds an adversary, than to grant him his whole argument, and at the same time either to shew that it is nothing to the purpose, or to offer something else, which may invalidate it. Of the use of this figure we have examples in Cicero's defence of Ligarius, who was accused by Tubero for having joined with Pompey in the civil war between him and Cæsar, (cap. 1.); and in the affair of Roscius, where the proof depended upon circumstances; and when Cicero, who defended him, inquires what reason could be alledged for his committing so black a crime, as to kill his father, (cap. 27.) Cicero has also given us an example of a feigned or ironical concession in his defence of Flaccus (cap. 38.); when interceding for him on account of his former good services, in the time of Catiline's conspiracy, he says in the way of irony, if such things are to be overlooked, "let us appease the ghosts of Lentulus and Cethegus; let us recall those who are in exile, and let us be punished for our too great affection and love for our country." To these feigned concessions we may refer such modes of reasoning, by which the orator both justifies a charge brought against him, upon the supposition of its being true; and also proves that the charge itself is

false. Thus Cicero, in his defence of Milo, represents the taking off of Clodius, with which Milo was accused, as a glorious action; after he has shewn that Milo's servants did it without the knowledge of their master. (Cap. 10. and 27.)

EPITROPUS, a kind of judge, or rather an arbitrator, which the Greek Christians under the dominion of the Turks elect in the several cities, to terminate the differences that arise among them, and avoid carrying them before the Turkish magistrates. See ARBITRATOR.

There are several epitropi in each city. M. Spon, in his Travels, observes, that at Athens there are eight taken out of the several parishes, and called *vecchiardi*, *i. e.* old men. But Athens is not the only place where there are epitropi; they are in all the islands of the Archipelago.

Some Latin authors of the sixth century call epitropi those who more anciently were called *villici*, and since *vidames*.

In times still earlier, the Greeks used the term ἐπίτροπος, in the same sense as the Latins did *procurator*, *viz.* for a commissioner or intendant.

Thus the commissioners of provisions in the Persian army are called by Herodotus and Xenophon epitropi. In the New Testament, ἐπίτροπος denotes the steward of a household, rendered in the vulgate procurator.

EPIZEUXIS, in *Rhetoric*, a figure where the same word is repeated with vehemence in the same sense, without any others intervening, and suited to express anger, surprise, sorrow, and several other passions: thus *age, age; adeste, adeste*; and that of Virgil, *nunc, nunc, insurgite remis*, are instances of it. Thus also, when Cicero would express his indignation against Antony for having been the chief instrument in bringing on the civil war, he says to him: "You, you, Antony, pushed Cæsar upon the civil war." (Philip. ii. c. 22.) Thus he tells Catiline in his first invective against him; "You live, and live, not to lay aside, but to pursue your wicked design." (Ibid. cap. 2.) See Matthew xxiii. 37. The use of this figure shews the earnestness of the speaker and the great concern of his mind about what he says, and has a natural tendency to excite the attention of the audience.

EPIZOOTIC STRATA, or *Mountains*, in *Geology*, are such as contain remains of animals, which a very large portion of all those upon the surface of the earth seem to do, although their reliquæ are by no means equally numerous in all strata, probably owing to their not being preserved in every instance, so that their remains or impressions can be now traced.

EPIZOOTY, a denomination given to an epidemical or contagious distemper among horned cattle. M. de Saive, apothecary to the prince bishop of Liege, has given the following instructions for the prevention and cure of this disorder. As soon as any symptoms of the distemper are perceived, about 1½ pint of blood should be taken from the beast, unless he has been ill a day or two, in which case he should not be bled; but in both cases the following draught should be given, *viz.* N<sup>o</sup> 1. an ounce of the best Venice treacle dissolved in a pint of vinegar, after which the back-bone and the whole hide must be well rubbed with a dry hair cloth, to heat the hide and promote perspiration. No drink should be given him; but a white drink composed of (N<sup>o</sup> 2.) a handful or two of rye-meal in a pailful of clean water; and if the beast should want food, mix up some crumbs of rye bread with some of this white drink, and give it him. The animal's mouth must be washed twice a day with a cloth dipped in a mixture of (N<sup>o</sup> 3.) equal quantity of vinegar and water, with a spoon-

ful of honey to a pint of it. If on the second day the beast has not dunged, a clyster composed of (N<sup>o</sup>. 4.) a pint of water in which bran has been boiled, two spoonfuls of salt, and a small glass of vinegar must be given and repeated every day till the evacuations are natural and regular. Besides the above remedies, the following cordial mixture (N<sup>o</sup>. 5.) viz. a pint of clear water, the same quantity of vinegar, four spoonfuls of honey or syrup, and two glasses of brandy, must be given four times a day to facilitate and keep up perspiration; taking particular care to repeat the friction as above directed. If the beast should still continue low and heavy, the draught (N<sup>o</sup>. 1.) must be repeated, unless he should be found to be hot and thirsty, in which case only the drink (N<sup>o</sup>. 2.) should be used. On the fourth day, if he seems more lively and free from heat, purge him with (N<sup>o</sup>. 6.); two ounces of salts and one ounce of common salt, dissolved in a pint of lukewarm water, with two spoonfuls of honey. If this does not procure four or five evacuations, repeat the clyster the same day.

This mode of treatment must be continued without intermission till the beast begins to eat; then he must have only the white drink (N<sup>o</sup>. 2) and a little good fodder, or some rye-bread dipped in stale-beer, moderately sweetened with honey or syrup. The exterior treatment consists in the application of setons in the beginning of the distemper, at the bottom of the dewlap, and of cauteries towards the horns, between which some weight, *e. g.* a stone of a pound weight or more, wrapped up in a cloth, must be fixed in order to keep it steady. This is necessary to keep the head warm. But above all, the friction must be carefully attended to, for determining the critical efforts of nature. It would be proper also to evaporate vinegar in the cow-house, &c. and if it could be done without risk, blowing of a few grains of gunpowder in them twice a day would be a very useful fumigation. If, notwithstanding these aids, the beast be not perfectly cured in ten or twelve days, they must be continued without bleeding, unless the inflammation be very considerable; but if, after all, the distemper does not give way, the beast must be killed, buried very deep, and well covered with earth and turf, for the purpose of preventing the exhalation of the putrid vapours and the spread of the infection. The principal preservatives from infection consist in washing the racks, troughs, &c. and the hide of the beast every day, with plenty of water; and instead of expensive aromatic fumigations sometimes recommended, the use of fires made with the branches of green wood, with pitch thrown on it to quicken the flames and perfume the air. Common salt given in small quantities every day to horned cattle, is reckoned an excellent preservative, particularly in a learned dissertation on the contagious distempers among horned cattle, by M. de Limborg, M.D. F.R.S. Letters, &c. on Agriculture of the Bath, &c. Society, vol. i.

EPLOYE', in *Heraldry*. An eagle employé is what in English we more usually call an eagle displayed, or a spread eagle. See DISPLAYED.

EPNEUMATOSIS, from *πνευματος*, *I breathe*, in *Medicine*, the same with expiration.

EPOBOLIA, in *Antiquity*, a fine laid upon those that could not prove the indictment they had brought against their adversaries.

It was so called, because they were obliged to pay the sixth part of the value of the thing they contended for, viz. an obolus out of every drachm. Some of these sums were deposited in all law-suits, a very few excepted, before the trial could proceed. Potter. *Archæol. Græc. lib. i. cap. 21. tom. i. p. 117.*

EPOCH, in *Astronomy*, is the mean longitude of a planet for the commencement of a given year. It is one of the principal elements of the elliptic motion. (See ELEMENT and ELLIPTIC Motion.) When two observations of a planet are made in the mean distances, that is, at three and nine signs of mean anomaly, it is then practicable to correct, by two such observations, both the epoch and equation of the centre. If the latter is exact, there will be no other difference between the calculation and observation than the epoch of the mean motion, since the place of the aphelion does not influence the longitudes taken at the mean distances; the error will, therefore, be equal in the two observations, for we suppose the mean motion known exactly. Thus, if the errors of the tables are found equal at three and nine signs of anomaly, it is a proof that the equation of the centre is exact, and that the error lies wholly in the epoch being improperly assumed.

EPOCHÆA, in *Chronology*, a term or fixed point of time, whence the succeeding years are numbered or accounted.

The word is *εποχη*, *q. d. inhibitiō, repressiō*, formed of *επιχειν*, *to sustain, stop*, because the epocha defines or limits a certain space of time. For the difference between epocha and era; see ÆRA.

Different epochas obtain in different nations; and no wonder; for there being no astronomical consideration to render one preferable to another, their constitution is purely arbitrary. That principally regarded among Christians is, the epocha of the Nativity or Incarnation of Jesus Christ; that of the Mahometans, the Hegira; that of the Jews, &c. the Creation of the World; that of the ancient Greeks, the Olympiads: that of the Romans, the Building of the City; that of the ancient Persians and Assyrians, the epocha of Nabonassar, &c.

The doctrine and use of epochas are of very great extent in chronology.

To reduce the years of one epocha to those of another, *i. e.* to find what year of one corresponds to a given year of another; a period of years has been invented, which, commencing before all the known epochas, is, as it were, a common receptacle of them all, called the Julian period. To this period all the epochas are reduced, *i. e.* the year of this period whereon each epocha commences is determined. All that remains, therefore, is, to add the given year of one epocha to the year of the period corresponding with its rise; and from the same to subtract the year of the same period corresponding to the other epocha; the remainder is the year of that other epocha.

EPOCHÆA of *Christ*, or of our Lord, is the vulgar epocha throughout Europe, commencing from the supposed time of our Saviour's nativity, December 25, or rather according to the usual account, from his circumcision, that is, from the first of January.

Now, the year of the Julian period, wherein Christ was born and circumcised, is usually computed to be the 4713th; consequently, the first year of the era of Christ corresponds to the year 4714 of the Julian period.

Hence, 1. If to any given year of Christ you add 4713; the sum will be the year of the Julian period corresponding thereto, *E. gr.* If to the year 1809 be added 4713, the sum 6522 is that year of the Julian period.

2. On the contrary, subtracting 4713 from any given year of the Julian period, the remainder is the current year of Christ. *E. gr.* from the year of the Julian period 6522; subtracting 4713, the remainder is the year of Christ 1809.

In effect, the epocha of our Lord serves not only for the computation

## E P O C H A.

computation of the years elapsed since the epocha commenced, but even of those before it.

Now, to find the year of the Julian period corresponding to a given year before Christ, subtract the given year from 4713, the remainder is the correspondent year required. Thus, *e. gr.* the year before Christ 752, is the year 3961 of the Julian period. On the contrary, subtracting the year of the Julian period from 4713, the remainder is the year before Christ.

The author of the vulgar epocha, or way of computing from Christ, is an abbot of Rome, one DIONYSIUS *Exiguus*, (which see,) by nation a Scythian, who flourished under Justinian about the year 507, or, according to others, 527, though this Dionysius borrowed the hint from Panodorus, an Egyptian monk. Till his time, the generality of Christians computed their years either from the building of Rome, or according to the order of the emperors and consuls, and by other ways in use with the people among whom they lived.

This diversity occasioning a great distraction between the churches of the East and West; Dionysius, to compose the same, first proposed a new form of the year, with a new general era, which in a few years time was generally admitted.

Dionysius began his account from the conception or incarnation, by us popularly called Lady-day, or the Annunciation; which method obtained in the dominions of Great Britain till the year 1752, before which time the Dionysian and English epocha was the same; but in that year the Gregorian calendar having been admitted by act of parliament, they now reckon from the first of January, as they do in the other countries of Europe, except in the court of Rome, where the epocha of the incarnation still obtains for the date of their bulls.

It must be added, that this epocha of Dionysius is charged with a mistake: the common opinion is, that it places our Saviour's nativity a year too late; or that he was born the winter preceding the time prescribed by Dionysius for his conception.

But the truth is, the fault lies on Bede, who misinterpreted Dionysius, and whose interpretation we follow, as has been shewn by Petavius from Dionysius's own epistles; for Dionysius began his cycle from the year 4712, but his epocha from the year 4713, wherein the vulgar era supposes Christ to have been incarnate.

The year, therefore, which, according to the vulgar epocha, is the first year of Christ, according to Dionysius's era is the second; so that the year which we call 1809, should, in justice, be 1810, though some chronologers, instead of one year, will have the error two.

Others suppose that the Dionysian era is four years too late; which supposition is confirmed by considering that our Saviour was born before the death of Herod the Great; and during the reign of Augustus (Matth. ii. 1. 22. Luke, ii. 1.) and according to the testimony of Josephus, (lib. xvii. cap. 18.) there was an eclipse of the moon in the time of Herod's last illness; which eclipse appears to have happened in the year of the Julian period 4710, March 13, at Jerusalem. Now, as our Saviour must have been born some months before Herod's death, since in the interval he was carried into Egypt, the latest time in which we can fix the true era of his birth is about the end of the 4709th year of the Julian period.

In order to ascertain the true year of our Saviour's birth, it is necessary to fix the precise time of Herod's death. The chief opinions concerning the time of this event are three. Some think he died a little before the passover of

A. U. 750, Julian year 42; others on Nov. 25 in that year: and others, a short time before the passover A. U. 751. We learn from Josephus, (De Bell. lib. ii. c. 1. Antiq. l. xvii. c. 9.) whose authority we cannot reject in deciding this question, that Herod died but a short time before one of the Jewish passovers. That Herod died a short time before the passover A. U. 750, Julian year 42, is argued in this manner. His distemper had made great progress before the pulling down of the golden eagle at the temple. The Jewish rabbies excited their scholars to this action. News being brought that Herod was *dying* (Jof. de Bell. l. i. c. 33. § 1.) or *dead* (Jof. Ant. l. xvii. c. 6. § 3.) these rabbies were taken up and carried to Jericho, where Herod was, in a very infirm state, and where they were tried and burnt to death. On that very night there was an eclipse of the moon, which, as we have already mentioned, happened March 13th A. U. 750. From this time Herod grew worse and worse; so that he could not live long. The passover of this year happened on the 11th of April; and the interval between the 13th of March and 11th of April would have been sufficient for every thing that Josephus has related concerning Herod's illness; the settling of his affairs, the execution of Antipater, Herod's death and funeral, which are the occurrences between the eclipse and Archelaus's coming to Jerusalem at the passover.

Besides, from circumstances related by Josephus concerning Archelaus, one would be apt to conclude, that he reigned nine years complete, and that the 10th year was current when he was banished. Dio (l. lv. p. 567.) places Archelaus's banishment in the 759th year of Rome. If Herod did not die, as some imagine, till the beginning of A. U. 751, the 9th year of Archelaus's reign could not be completed in the 759th year of Rome. But if Herod be supposed to have died in the beginning of A. U. 760, Josephus and Dio agree. Moreover, Josephus says, that Cyrenius seized Archelaus's estate, and finished the assentment in Judea in the 37th year after the defeat of Antony at Actium by Cæsar Augustus. The victory at Actium was obtained Sept. 2, A. U. 723; therefore the 37th year from it begins Sept. 2, A. U. 759, and ends Sept. 2, 760. Supposing then that Herod died in the beginning of A. U. 750, there is in this particular also a very good harmony between Josephus and Dio. Besides, Josephus informs us (Ant. l. xiv. c. 29.) that Herod was appointed king by the Roman senate A. U. 714. *i. e.* 40 years before the vulgar era. The same historian observes, that he died in the 37th year of this reign, and 34th after the death of Antigonus, *viz.* in the 42d Julian year (Antiq. l. xvii. 10.) If to 713 we add 37, the sum will be 750, the year of Rome in which this prince died.

The opinion, adopted by other learned men, that Herod died a short time before the passover A. U. 751, labours under several great difficulties, which are pointed out by Dr. Lardner (*ubi infra*). Upon the whole it appears, that Herod did not die before the year 750, nor survive the year 751, and that he died a short time before the Jewish passover of one of these years. It follows, that if Herod died in 750, he died three years and nine months before the vulgar Christian era, which commences January 1, A. U. 754; if at the time above-mentioned, in the year 751, then he died about two years and nine months before the said era. "Which is the truth," says Dr. Lardner, with his usual diffidence and modesty, "I am not able to determine." Accordingly he says, that "if Herod died in March A. U. 750, I should be inclined to place the nativity of Jesus in September or October, A. U. 748; if Herod died in March 751, then the nativity of Jesus might  
very

very well be placed in September or October 749." The birth of Jesus must be dated about a year and five or six months before the death of Herod, *i. e.* before the latter end of the year of Rome 748 or 749, *i. e.* 4708 or 4709 of the Julian period; but for reasons already assigned, the latter date is the most probable.

We shall here add, that an objection has been urged against the 15th year of the reign of Tiberius, compared with the age of Jesus at his baptism. (Luke, iii. 1, 2. 23.) If Jesus, it is said, was born above a year, much more, if above two years before Herod's death, then the age of 30 years, here ascribed to him at his baptism, is absolutely inconsistent with the notes of time mentioned at the commencement of John the Baptist's ministry; even allowing, that *the word of God came to John* in the very beginning of the 15th year of Tiberius, and that Jesus was baptized a few months after. Dr. Lardner observes, that the true meaning of these words, *Jesus himself began to be about 30 years of age*, is not that he then entered the 30th year of his age, but that Jesus was about 30 years of age when he began his ministry. This, he says, is now the general opinion of learned men; so the Greek word of this text is used by St. Luke in other places. The objection is thus stated: Augustus died, and Tiberius succeeded him the 19th of August, A. U. 767, Julian year 59, A. D. 14. Therefore the 15th of Tiberius began the 19th Aug. A. U. 781, A. D. 28. Herod died before the passover, in A. U. 751, Jul. year 43. If then John the Baptist began to preach in the beginning of the 15th of Tiberius, in the latter end of A. U. 781, and Jesus be supposed to have been baptized by John a few months after, on the 6th of January of the year following, *viz.* A. U. 782, Jesus must have been in the 32d year of his life, if Herod died in the spring, *viz.* A. U. 751, and if Jesus was born the 25th of December preceding, *viz.* A. U. 750. But if Herod died A. U. 750, and Jesus was born the 25th December before, *viz.* A. U. 749, then he would be at his baptism in the 33d year of his age. But it may be made to appear in several ways, that Jesus was born above a year, probably above two years before Herod died. Dr. Lardner has stated this objection in its full force; and detailed several circumstances that tend to obviate it. From some of them he infers, that there is no necessity of placing the birth of Jesus above a year and six months before the death of Herod, as we have already stated. As it is most probable that Herod died A. U. 750, we may be disposed, from other circumstances alleged by this accurate and impartial writer, to place the nativity of Jesus in September or October A. U. 748. The latter part of the summer, or the autumn season, seems to be the most likely time of the year for the birth of Jesus; nor is there any particular reason that should determine us to the 25th of December. The very depth of winter was not a very proper season for a survey and assessment, when people are to enter themselves according to their tribes or families; the autumn, when harvest and vintage are over, would be a time of general leisure. When Jesus was born in Bethlehem, *there were in the same country shepherds abiding in the field, keeping watch over their flocks by night*, (Luke, ii. 8.) This circumstance is not very favourable to the supposition, that Jesus was born the 25th of December; and we are at liberty to place it in autumn, a more likely season. (See CHRISTMAS.) It is not improbable then, that Jesus might be born some time between the middle of August and the middle of November. Cyrenius, we may suppose, came into Judea at the time, or soon after the time, that Varus became governor of Syria (before Sept. A. U. 748), and published the decree of Augustus, requiring all peo-

ple to enter themselves, their dependents, and estates. This assessment could well be made in a country of such small extent as Judea in two or three months; and the short time appointed for this work may be inferred from the peculiar circumstances of Cyrenius, who wished to hasten back to Rome, and also from St. Luke's history of it. Upon the whole, we may conclude, that about a year and six or seven months before the death of Herod, soon after the arrival of Varus in the province of Syria, in August or September A. U. 748 or 749, Julian year 40 or 41, Cyrenius (or some other person of eminence) came into Judea, an assessment was made there, and in the time of it, Jesus was born at Bethlehem, in the month of September or October. In order, however, to settle satisfactorily the 15th year of the reign of Tiberius, we should consider that the commencement of his reign may be computed from a different period than that of his sole empire, after the death of Augustus. In fact, it appears, that there were two different dates of the beginning of Tiberius's reign; one from the time of his being made colleague with Augustus, and the other from his sole empire, after the death of Augustus. Many learned writers are of opinion, that St. Luke intends the former of these two computations, referring to a period two years before the death of Augustus, *viz.* in A. U. 765, when Piso was præfect of Rome, Tiberius being prince. Archbishop Usher and Prideaux place the beginning of this government of Tiberius in this year. This epoch of Tiberius's empire was followed for some time by some persons, in the provinces at least; but it is not so certain, when this pro-consular empire began, whether about two years, or about three years before Augustus died. If Tiberius's proconsular empire began about three years before Augustus died, on the 28th of August A. U. 764, A. D. 11, then this 15th of Tiberius's reign (according to this computation of it) began August 28th, A. U. 778, A. D. 25. Supposing that John the Baptist began his ministry November following, in the same year, and that Jesus was baptized by him the 6th of Jan. following, in A. U. 779, A. D. 26; then upon the supposition that Jesus was born in Sept. A. U. 748, he would be at his baptism 30 years of age, and some months more. If Tiberius's proconsular empire commenced about two years before the death of Augustus, in A. U. 765, A. D. 12, then the 15th year of the reign of Tiberius began in A. U. 779, A. D. 26. And supposing that John the Baptist began his ministry in November of that year, and that Jesus was baptized by him the 6th of January following, A. U. 780, A. D. 27, then, upon the supposition that Jesus was born in September, A. U. 749, he would be at the time of his baptism 30 years of age, and some months more; or, if born A. U. 748, he would be somewhat more than 31 years of age. Again, if John the Baptist began his ministry in the 15th of Tiberius, A. U. 778, A. D. 25, according to the first statement, but did not baptize Jesus till the 6th of January, A. U. 780, A. D. 27, after he had preached somewhat above a year, then Jesus would be at his baptism 30 years of age and odd months, if he was born A. U. 749; 31 years of age and some odd months, if born the latter end of the year 748. Such will be the result, if we take those dates of these events, which appear most favourable to St. Luke; since it is not absolutely certain when Herod died, or when Tiberius's proconsular empire began. But if we allow on each hand the dates least favourable to St. Luke's numbers, *viz.* that Jesus was born A. U. 748, and that he was not baptized till January A. U. 780, A. D. 27; yet even then Jesus would be little more than 31 years of age; at which time a person

person may be said very properly to be ABOUT *thirty years of age*.

The question of our Lord's nativity and age at his baptism is amply discussed, and the difficulties which it involves accurately and impartially examined, by Dr. Lardner in his "Credibility, &c." See his Works, vol. i. See also Playfair's System of Chronology, p. 49, &c.

Learned men have differed in opinion concerning the precise time of the death of Christ. Some have referred this event to the 29th year of the vulgar era; others to the 31st; and not a few to the 33d. Playfair (with whom Blair agrees) inclines to adopt the last of these dates, for the following reasons. 1. There is no other year besides the 33d of the vulgar era, 78th Julian year, 4746th of the Julian period, A. U. 786, to which this event can be properly referred; for Jesus Christ went to eat the passover with his disciples on the evening of the 14th of the first month, and was crucified on the day following, *viz.* on Friday, April 3d, the 16th day of the paschal moon, according to the true, and the 15th, according to the Jewish computation. 2. The 70 weeks of Daniel, which began in the 20th year of Artaxerxes Longimanus, and ended in J. P. 4746, when Messiah was cut off. 3. Phlegon, the freedman of Adrian, and esteemed as an exact computer of the Olympiads, observed "that in the 4th year of the 202d Olympiad, there was a miraculous darkness; for at the sixth hour of the day came on night, insomuch that the stars of heaven were seen. At the same time, there was also a great earthquake in Bithynia, which threw down part of the city of Nice." (Compare this account with Matth. xxvii. 45. and Luke, xxiii. 45.) The 4th year of the 202d Olympiad answers to the first six months of the 33d year of our vulgar era, and to the 19th of the reign of Tiberius. Concerning the testimony of Phlegon; see PHLEGON. 4. When Christ suffered, Pontius Pilate was governor of Palestine (Tacit. l. xv. Joseph. Antiq. l. xviii. c. 5.); Herod Antipas was tetrarch of Galilee (Luke, xxiii. 6. Joseph. Antiq. l. xix. c. 7.); and Caiaphas was high-priest among the Jews (John, xi. 49. Luke, iii. 2. and Acts, iv. 6.) (See CAIAPHAS.) From these and other characters it appears, says Playfair, that Jesus Christ lived about 36 years, 3 months, 9 days, and 15 hours, if we reckon (according to the generally received opinion concerning the month and day of his nativity) from midnight of December 25th, of the 42d Julian year commencing, to April 3d and 3 in the afternoon, of the 78th Julian year. His resurrection took place on Sunday April 5th, and his ascension on Thursday May 14th.

To the vulgar era of our Lord's nativity, as a sure fixed point, chronologers have been accustomed to reduce all the other epochs, though there is not one of them but what is controverted; so much uncertainty there is in the doctrine of time. We shall exhibit them as reduced to the Julian period.

ΕΠΟΧΑ of the Creation, *Orbis Conditi*, according to the computation of the Jews, called also the Jewish epocha, is the year of the Julian period 953, answering to the year before Christ 3761, and commencing on the seventh day of October. Hence subtracting 952 years from any given year of the Julian period, the remainder is the year of the Jewish epocha corresponding to it. Thus, *e. gr.* the year 1809 being the 6522d year of the Julian period, it is the 5570th year of the Jewish epocha, or since the creation of the world.

This epocha is still in use among the Jews.

The ΕΠΟΧΑ of the Creation, used by the Greek historians, is the year before the Julian period, 787, answering to the year before Christ 5500.

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Hence, to any given year of the Julian period, adding 787, the sum gives the year of this epocha. *E. gr.* 1809 being the 6522d year of the Julian period, 7309 is that year of this epocha, or the year of the world, according to this computation.

The author of this epocha is Julius Africanus, who collected it from the historians: but when it came to be admitted into civil use, 8 years were added to it, that so every year thereof divided by 15 might exhibit the indication, which the eastern emperors used in their charters and diplomas.

The epocha of the creation used by the latter Greeks and Russians is the year 795 before the Julian period, or the year 5508 before Christ, commencing from the first day of September. Though the Russians, having lately admitted the Julian calendar, begin their year from the first of January.

Hence, adding 795 to the year of the Julian period, the sum gives the year of this epocha. Thus, *e. gr.* the Julian period of the year 1809 being 6522, that year of this epocha, *i. e.* the years from the creation on this footing are 7317. Again, from that year 7317 subtracting 5508, the remainder is the year of the common era 1809. This era was used by the emperors of the East in their diplomata, &c. and thence also called the "civil era of the Greeks." In reality, it is the same with the epocha of the Constantinopolitan period; whence some call it the "epocha of the period of Constantinople."

The Alexandrian ΕΠΟΧΑ of the Creation is the year 780 before the Julian period, answering to the year before Christ 5493, and commencing on the 29th day of August.

Hence, adding 5493 to the year of Christ 1809, the sum 7302 gives that year of this epocha, or years elapsed since the creation, according to this computation.

This epocha was first concerted by Panodorus, a monk of Egypt, to facilitate the computation of Easter; whence some call it the "Greek ecclesiastical epocha."

The Eusebian ΕΠΟΧΑ of the Creation, is the year of the Julian period 486, answering to the year before Christ 4228, and commencing in autumn.

Hence, subtracting 486 from the year 6522 of the Julian period, or adding 4228 to the year of Christ 1809, the result 6036 will be that year of this epocha.

This epocha is used in Eusebius's Chronicon, and the Roman Martyrology.

The ΕΠΟΧΑ of the Creation, according to Mr. Bedford and Mr. Kennedy, is the year of the Julian period 706, answering to the year before Christ 4007.

The ΕΠΟΧΑ of the Creation, according to archbishop Usher, adopted in Blair's tables, is the year of the Julian period 710, corresponding to the year before Christ 4004; but it must be allowed, that all the epochs of the creation are uncertain. See Strauchius's Brev. Chron. by Sault. p. 152, &c. See chronological table under the article CHRONOLOGY.

ΕΠΟΧΑ of the Universal Deluge, in the year of the creation 1656, and according to the different methods of computation; see the table under CHRONOLOGY, and ANTE-DILUVIAN.

ΕΠΟΧΑ of the Olympiads, is the year of the Julian period 3938, answering to the year 776 before Christ, commencing at the full moon next the summer solstice, and each Olympiad containing four years.

This epocha is very famous in ancient history; it was used principally by the Greeks, and had its origin from the Olympic games, which were celebrated at the beginning of

every fifth year. See the table above cited, and OLYMPIC Games.

EPOCHÆ of the Building of Rome, or *Urbis Condita*, U. C. is the year of the Julian period 3961, according to Varro; or 3962, according to the *Facti Capitolini*, answering to the year before Christ 753 or 752, and beginning on the 20th of April. Hence, if the years of this epocha be fewer than 754, subtracting them from 754 or 753, you have the year before Christ; and, on the contrary, if they be more than 754, you must subtract 754 to have the year of Christ, and add the year of Christ to 754 to have the year of this epocha, or the time since the building of Rome. Thus, *e. gr.* the year 1809, according to Varro, is the year of Rome 2563.

The sentiments of the earliest Roman writers, with respect to this epoch, are various; Polybius refers it to the year B. C. 751. Cato, whose opinion is adopted by Solinus, Eusebius, Dionysius Halic. &c. places it one year earlier. Fabius Pictor, who flourished in the time of the first Punic war, and who is styled by Dion. Hal. an accurate writer, brings it down to the 29th year of the olympiads, *i. e.* 747 B. C. Diodorus Siculus adopts this opinion. Sir Isaac Newton, on the testimony of some later Roman writers, observes that Rome was built in the 15th age after the destruction of Troy, that is, after the 14 kings who reigned in Alba. Allowing 21 years to the reign of every king, and computing from the year B. C. 904, when he supposes Troy to have been taken, he brings forward this epoch to the 38th olympiad, *i. e.* 627 B. C. The date of Varro has been adopted by the Roman emperors in their proclamations, by Plutarch, Tacitus, Dion, Gellius, Censorinus, Onuphrius, Baronius, and by most modern chronologers.

EPOCHÆ of *Nabonassar*, is the year of the Julian period 3967, answering to the year before Christ 747, commencing the 26th day of February of the Julian year at mid-day. The solar cycle was 19, the lunar 15, and the cycle of indiction 7.

This era takes its denomination from its institutor Nabonassar king of Babylon, and is that used by Hipparchus, by Ptolemy in his *Astronomical Observations*, by Censorinus, and others.

This epoch is of singular service in chronology, as it serves to connect and adjust all other epochas. The form of this era, which included a period of 424 Egyptian years from the commencement of Nabonassar's reign to the death of Alexander the Great, and which was thence carried down to the reign of Antoninus Pius, is singular. Every year consists of 365 days, and is divided into 12 months. Every month contains 30 days; five intercalary days are added to these months, and the sum composes the quantity of the Nabonassarean year. In every four Julian years, the corresponding four years of this era were evidently deficient by one day; therefore the beginning of the Nabonassarean years must have moved retrogradely; and in the space of 1460 Julian years, must have gone through every day of the year. Whence it appears, that 1460 Julian are equal to 1461 Nabonassarean years. If the first year of the era of Nabonassar began on Wednesday, Feb. 26th, the second and third years must have begun on the same day; because these two years contain 365 days each in the Julian, as well as in the Egyptian calendars. The following year, *i. e.* 744 B. C. being a bissextile, one day was added to the Julian year, consequently the Nabonassarean year began on Feb. 25th in this and the three succeeding years. In the year 740 B. C. it began on February the 24th; in 736 B. C. on February

the 23d, &c. The first day of any year of the Nabonassarean era may be found by the following general rule.

Divide the given year by 4 (because in 4 years the Nabonassarean year anticipates the Julian by one day), and the quotient will be the number of days of anticipation, or of the omitted leap-days. If the quotient be less than 57 (the number of days from January 1st to February 26th), let it be subtracted. If the quotient exceeds 57, subtract it from 422, *i. e.* from 57 + the number of days in one Julian year, and the remainder will be the day of the Julian year, reckoned from January 1st, which is the *Thoth*, or first day of the year following the given one; (*Thoth* being the name of the month, which in the first year of this era corresponded to Feb. 26th of the Julian year.) From the day found, subtract 1, and the remainder will be the number of the day required.

E. G. On what day of the Julian year did the *Thoth* of the Nab. era 230 fall? Divide 230 by 4, and the quotient 57, subtracted from 422, leaves a remainder of 365. This shews that the *Thoth* of N. E. 231st falls on December 31st, or on the 365th day of the Julian year: subtract 1, and the remainder 364, or December 30th, will be the day required.

EPOCHÆ, or *Era of Constantinople*, is supposed to have commenced before the creation of the world; for the 5509th year of it answers to the 1st of the vulgar Christian era. It was adopted by the Greek church and empire, all the public acts of which are still dated by it; and the Muscovites computed by it until the reign of Peter the Great. Those who reckon by it make use of civil and ecclesiastical years. The former begin with the month of September, and the latter, sometimes with the 21st of March, and sometimes with the 1st of April.

EPOCHÆ of *New Rome*, or *Constantinople*, is usually computed from the time of the consecration of the city. Accordingly the first year of this era was the 25th of the reign of Constantine, A. M. 5838, as the modern Greeks estimate the era of the creation, Julian period 5043. Thus directed, the consecration of the city is fixed in the 330th year of the vulgar era, on the 11th of May.

EPOCHÆ, *Dioclesian*, or *Epocha of Martyrs*, is the year of the Julian period 4997, answering to the year of Christ 284, called the "era of martyrs," from the great number of Christians who suffered martyrdom under the reign of that emperor.

The Abyssinians, among whom it is still used in all ecclesiastical computations, call it the "year of grace;" though they do not reckon their years in a continued series, from this epocha. But when the Dionysian period of 534 years is expired, they begin their computation afresh from 1, 2, &c.

EPOCHÆ of the *Hezira*, or *Mahometan Epocha*, is the year of the Julian period 5335, answering to the year of Christ 622. It commences on Friday the 16th of July, the day of Mahomet's flight from Mecca to Medina.

This epocha is used by the Turks and Arabs, and even all who profess the Mahometan faith. It was first introduced by Omar, the third emperor of the Turks. The astronomers Alfraganus, Albategnius, Alphonfus, and Ulugh Beigh, refer Mahomet's flight to the 15th of July; but all the people who use the epocha agree to fix it on the 16th. See HEGIRA.

EPOCHÆ of the *Seleucida*, which is used by the Macedonians, is the year of the Julian period 4402, answering to the year before Christ 312. This is reckoned from the time when Seleucus, one of the generals of Alexander's army, took Babylon and ascended the Asiatic throne.

This era is sometimes called the Grecian era, and the era of Principalities, in reference to the division of Alexander's empire. The Arabians style it "Tarik Dhilcarvaim," *i. e.* the era of Contracts, and the Greeks denominate it the Horned era. Those who use it reckon sometimes by Nabonassarean years, and sometimes by Julian, composed of Roman months, to which Syrian names have been affixed. Its commencement has been variously stated, some date it on Tuesday March 13th. The Greeks in Syria reckon from a month corresponding to our September. Albategni, and others, reckon from the 1st of October. In the first book of Maccabees the year is said to have began in Nisan, or the first month of spring; but in the second book, and in other Jewish histories, its beginning is dated in Tizzi, which is the first month of autumn. See SELEUCIDÆ.

EPOCHÀ, *Persian*, or *Yezdegerdic*, is the year of the Julian period 5345, answering to the year of Christ 632, and commencing on the 16th of June.

This epocha is taken from the death of Yezdegerdis, the last king of Persia, slain in battle by the Saracens. See *Persian CALENDAR*.

EPOCHÀ, or *Era of the Persian Monarchy*, is referred by almost all ancient historians to the 1st year of the 55th olympiad, *i. e.* 560 B. C. Of this opinion are Diodorus Siculus, Thallus, Censor, Polybius, Phlegon, and Eusebius. From the beginning of the Nabonassarean era to the first year of the reign of Cyrus over Babylon, Ptolemy reckons 209 years. If this number be subtracted from 747, the remainder 538 will be the Babylonian epoch of Cyrus; and the monarchy stood, according to Agathias, from the first year of Cyrus 228 years. That this was its duration is evident from a passage of Plutarch (in Vit. Alex.) which mentions an eclipse of the moon that happened 11 days before the last battle between Darius and Alexander, in the month Boedromion. This eclipse is found, by calculation, to have coincided with the 446th olympic year, Sept. 20. It, therefore, the difference be computed between the 550th olympiad, *i. e.* the 217th olympian year, when the Persian empire began, and the 446th, when it ended, it will appear to have flourished 228 or 229 years.

EPOCHÀ, *Gelalaan*, called also *Royal Epochà*, and *Epochà of the Sultans*, began in the year of the Julian period 5787, A. D. 1074, on the 14th day of March, at the time of the equinox, and was established for the convenience of finding the vernal equinox, at which time the Persians celebrated their great feast, called *Neuruz*. See *Persian CALENDAR*.

EPOCHÀ of the establishment of the Roman Consular dignity. The republican form of government in Rome owed its origin to the tyranny of Tarquin the seventh king; in consequence of which the sovereign authority was divided, and two magistrates were elected under the denomination of consuls. The consular dignity was conferred on Brutus and Collatinus, 244 years after the building of the city. The names of the consuls were registered in the calendars until A. D. 541; and in the 15th year of Justinian the order was abolished. See CONSUL.

EPOCHÀ, *Julian*, or *Epochà of Julian years*, is the year of the Julian period 4668, answering to the year before Christ 46.

This epocha had its origin from the year of the reformation of the calendar under Julius Cæsar, called the "year of confusion."

EPOCHÀ, *Gregorian*. See GREGORIAN.

EPOCHÀ, *Spanish*, is the year of the Julian period 4676, answering to the year before Christ 38.

This era commenced at the time of the second division of

the Roman provinces among the Triumviri, and is reckoned from the 1st of January in the year 38 B. C. so that the first year of the Christian coincides with the 39th year of the Spanish era. The most famous synods of Spain and Africa have been distinguished and described according to the computation of this era; but by a decree of the council of Taragon, A. D. 1180, the Christian era was substituted in its room, though it continued in use till the year 1383. The Portuguese were the last people who computed by this era, and they gave it up A. D. 1415 or 1422. See ÆRA.

EPOCHÀ, *Adiac*, or *Adian*, is the year of the Julian period 4684, answering to the year before Christ 30, commencing in Egypt on the 29th day of August, and on the 1st of September among the Greeks of Antioch; but among the Romans on the 1st of January in the year of Rome 724.

EPOCHÀ of the Reformation. See REFORMATION.

For other epochas or eras, and the dates of remarkable events, see the table under CHRONOLOGY.

EPOCHETEUSIS, from ἐποχέτω, *I draw through a canal*, of ὄχετος, *canal*, a word used by Hippocrates, and others of the old writers in *Medicine*, to express the derivation of the blood, or juices, from one part to another.

EPODE, ἔπος, in *Lyric Poetry*, the third or last part of the ode; the ancient ode, or song being divided into strophe, antistrophe, and epode.

According to its most common acceptation, it signified a number of Lyric verses of different construction, comprised in a single stanza; and it was sung by the priests, standing still before the altar, after all the turns and returns of the strophe and antistrophe. The invention of epodes is ascribed to Archilochus.

The epode was not confined to any precise number, or kind of verses, as the strophe and antistrophe were; but when the ode contained several epodes, strophes, &c. they were all alike.

As the word epode, then, properly signifies the end of the song; and as in odes, what they called the epode finished the singing, it became customary, as M. Dacier shews, for any little verse which, being put after another, closed the period, and finished the sense which had been suspended in the first verse, to be called epode, ἐποδός.

And hence it is, that the sixth book of Horace's Odes is entitled "Liber Epodan, Book of epodes," because the verses thereof are all alternately long and short; and the short one, generally, though not always, closes the sense of the long one. The name of epode was likewise given to a small Lyric poem, composed of trimeters or iambs, of six feet, and dimeters of four feet alternately. Of this kind were the epodes of Archilochus, mentioned by Plutarch. But the signification of the word is extended still farther; epode being become a general name for all kinds of short verses, that follow one or more long ones; and in this sense, a pentameter is an epode, after an hexameter, which in respect thereof is a pro-ode.

EPODOS, from ἐπι, and ὄδη, *song*, in *Medicine*, a word used to express the curing of diseases by incantation.

EPOICODOMESIS, from ἐπι, and ὄδομαι, *I build upon*, in *Rhetoric*, is sometimes used for what is otherwise called climax.

EPOISSES, in *Geography*, a small town of France, in the department of the Côte d'Or, 9 miles W. of Semur.

EPOMIS, ἔπωμις, in *Anatomy*, the upper part of the shoulder, reaching up to the neck.

The word is Greek, ἐπωμις, which primarily signifies a short cloak or mantle made to cover the shoulders.

Some authors apply the word epomis to the upper part of

the os humeri; but the ancient Greek physicians only use it for the muscular, or fleshy part, placed as above mentioned. See DELTOIDES.

EPOMPHALION, from *επι, upon*, and *ομφαλος, navel*, any medicine which purges, on being applied to the navel.

EPOPOEIA, *Εποποιεα*, in *Poetry*, the history, action, or fable, that makes the subject of an epic poem.

The word is derived from the Greek *επος, carmen, verse*, and *ποιω, facio, I make*.

In the common use of the word, however, epopoeia is the same with epos, or epic poem itself: in which sense it is defined a discourse invented with art, or a fable agreeably imitated from some important action, and related in verse, in a probable and surprising manner; with a view to form the manners, &c. See *EPIC Poem*.

EPOPS, in *Ornithology*, a name by which some of the ancient writers have called the bird we call the upupa, or hoopoe. See *UPUPA*, of which it is a species.

EPORA, in *Ancient Geography*, a town of Spain, 28 miles from Castulon, according to the Itinerary of Antonine. Pliny calls it Ripepora. It is thought to be *Montoro* in the diocese of Cordova. M. D'Anville places it on the river Bætis, in Bætica, N. E. of Corduba.

EPOREDIA, *Ιβρέε* a town of Gallia Transpadana, situated towards the west, on the Doria Major.

EPOTIDES, in the *Ancient Ship-Building*, two large thick pieces of wood on each side of the prow of a galley, which resembled two ears, whence they had their name.

The epotides were chiefly designed to ward off the blows of the rōstra of the enemies' vessels.

EPPHA, or *Ερηα*, in *Ancient Geography*, a country of Arabia, in the vicinity of the Midianites.

EPPING, in *Geography*, a market town in the hundred of Waltham, in the county of Essex, England, is irregularly built, and consists of two parts or assemblages of houses; one round the church, called Epping Upland; the other, nearly a mile and a half south-east from the church, called Epping Street. The latter is by far the largest, and consists of one wide street, nearly a mile in length, situated on the high road from London to Newmarket, on a ridge of hills extending to a considerable distance north and south. Here a market is held on Fridays: the chief commodities exposed for sale, are butter and poultry, which are chiefly purchased for the use of the metropolis. At the west end of the street is a small new chapel: and near the middle are the shambles. The inns and public houses are numerous. Epping is 17 miles from London; contains, in both divisions, 315 houses, inhabited by 1726 persons; it has two annual fairs.

EPPING Forest, is an extensive tract of good woodland, deriving its present name from the town, but was formerly called Waltham Forest, and in very remote ages the Forest of Essex. Since it obtained the latter appellation, it has, however, been greatly curtailed, many thousand acres having been grubbed up, and the land cultivated. This forest is under the jurisdiction of a lord warden and four verderers: the wardenship is hereditary in the family of sir James Tilney Long, bart.: the verderers are elected by the freeholders of the county, and retain their offices during life. The forest rights are as various as the tenures of the different manors that surround it. In this forest, though so near to London, wild stags are yet found; and a stag is annually turned out on Easter Monday, under an establishment patronized by the principal merchants of the city. The hunt is well supported: the kennel for the hounds, and the building belonging to the hunt, have been lately erected at the expence of several thousand pounds.

At a small distance to the south-east is Hainault Forest, famous through many centuries for a venerable tree, called Fairlop Oak, which is remarkable for its size, and also for an annual fair held on the first Friday in July under its branches, which overspread an area nearly 300 feet in circumference: the stem, which is rough and irregular, measures 36 feet in girth. Morant's History of Essex. Beauties of England and Wales, vol. v.

EPPING, a town of Germany, in the archduchy of Austria; 4 miles S. of Aigen.

EPPING, a post town of America, in Rockingham county, New Hampshire, taken from the N. W. part of Exeter, and incorporated, in 1741. It contains 1121 inhabitants, and lies 6 miles N. W. of Exeter and 23 W. of Portsmouth.

EPPINGEN, a small town of the kingdom of Bavaria, in the palatinate on the river Elsatz, 21 miles N. E. of Philipsburg, and 18 miles N. W. of Heilbrun. N. lat. 49° 12'.

EPROUVETTE, is a machine, of which there are several varieties, used for proving the strength of gun-powder. The principle of this invention, in whatever form it may be applied, is to ascertain how far a certain measure or weight of gun-powder is capable of overcoming the resistance either of a certain weight, or of a spring, whose pressure against the explosion is computed. The former is evidently the most regular, and, consequently, the best adapted to military purposes, wherein the strength of the powder is often of the greatest moment, not only on account of the advantages gained by the greatest concentration of force, but because in the mortar and howitzer practice it is necessary to have a very accurate knowledge of the powers of expansion in the powder when ignited; by which means shells may be thrown, with the greatest precision, to any intended distance; whence the explosion takes the greatest possible effect.

In our arsenals, an eight inch mortar is ordinarily employed as an eprouvette: being charged with two ounces of powder, and an iron ball of sixty-four pounds, the latter should be projected at least 150 feet; the elevation of the piece being 45°, and the bed being placed perfectly horizontal. We consider this to be a fair standard; though some powder made from the best materials, and fresh from the mill will sometimes exceed even 180 feet; while, on the other hand, weak powder, that is, such as has not been kept very dry, or that has been re-stored, will rarely make a range equal to 120, and generally not exceeding even 110 feet.

The above mode of proof relates to cannon-powder; that intended for the use of musketry is ascertained by an eprouvette of a different description; namely, a musket barrel, of which the interior is highly polished. This should, with a charge of only four drachms, impel a steel ball through fifteen wet elm boards, each a quarter of an inch in thickness, and placed at  $\frac{1}{4}$  of an inch asunder; the first being 39 feet and 10 inches distant from the muzzle of the barrel. We must confess this exact number of inches in the distance, appears to be more fastidious than necessary, for we are apt to believe, that, in experiments of this nature, the odd two inches, necessary to complete the fortieth foot, would by no means derange the process.

The French eprouvette for cannon powder comes very close to our's, they using a brass ball of 60lb. (French weight) whose diameter is 7 inches and 9 points, or  $\frac{3}{4}$  of a line, (French measure) with one line of windage, (or space between the shot and the sides of the bore.) The chamber holds precisely three ounces; which quantity of their best powder will throw the ball full 180 yards; their re-stored powder throwing it about 160 yards. But Mons. Lombard's

lard's experiments give a result of 250 yards, with the powder now manufactured at the French mills; the eprouvette being always elevated to 45°.

Fine powder is sometimes tried by means of a small machine resembling a pistol, of which the barrel is very substantial, and the bore not more than the eighth of an inch in diameter. Over the barrel is a circular plate, acted upon strongly by a spring, which offers considerable resistance to the revolution caused therein, by the action of the powder on a projection which shuts down close upon the muzzle. The bore being filled with powder, and the wheel, or plate, turned so that its projection closes the muzzle, the explosion will, in proportion to its force, throw up the projection, and cause the wheel to revolve: the power of the powder is supposed to be ascertained by means of figures on the circumference, which indicate how much the wheel has been thrown round.

But such a machine cannot possibly give a correct standard; it being so subject to variation; as is also that contrivance which causes the powder to act underneath the hammer of a pistol lock. The pan being filled, the powder should have force enough to throw the hammer back. We need not comment on the uncertainty of such an estimate.

EPSOM, or EBBESHAM, in *Geography*, a parish and formerly a market town in the hundred of Coptorpe, Surrey, England, is fifteen miles S.E. from London. In the year 1800 it contained 414 houses, and 2404 inhabitants. The houses are disposed chiefly on two sides of a long wide street, or public road, and are situated on the west side of Banstead Downs. These are distinguished for their fine sweet verdure, which is mostly grazed by sheep; and the Banstead mutton is much esteemed for its flavour. On these downs are annual horse-races, which are much frequented by gamblers and sharpers, from the metropolis. The church, above a mile from the centre of the village, was served for many years by the late Rev. Jonathan Boucher, who died here in the year 1804. A large old seat near the church, called *Durdans*, was originally built by George, the first earl of Berkley, with the materials brought from the palace of Nonfuch, when that celebrated royal mansion was taken down. The first house being destroyed by fire, another was erected, and subsequently possessed by the earl of Guildford. Several other spacious seats, and pleasant villas, are found in the vicinity of Epsom, among which are Woodcote Park, the late lord Baltimore's; and Pit's-place, which receives its name from being situated within the excavation of a chalk pit. It is a singular and curious place.

EPSOM, a post town of America, in Rockingham County, New Hampshire, E. of Pembroke, adjoining, 10 miles E. of Concord, and 45 N. W. of Portsmouth. It was incorporated in 1727, and in 1800 contained 1034 inhabitants.

EPSOM Salt and Water. This so much celebrated salt was first extracted from the purgative mineral spring at Epsom in Surrey, which had long been celebrated for its medicinal qualities, by Dr. Nehemiah Grew in 1675, who published a treatise concerning it (*De Natura Salis Cathartici Amari*.) Dr. Grew gave it the appropriate name of sal catharticus amarus, or bitter purging salt; which is still retained, together with the names of Epsom salt, magnesia vitriolata, or sulphat of magnesia of modern chemical nomenclature; which see for the chemical properties of this salt.

The original Epsom salt, or that which was procured by the evaporation of the Epsom water, was sold in London at a very high price. Afterwards it was prepared, very extensively, by chemists of the name of Moulton, about the

year 1708, by evaporating the water of some springs at the foot of Shooter's-hill; which were found to resemble that at Epsom. Soon after it was discovered, as appears by Haukwitz, a celebrated trading chemist in London, that the same salt could be procured from the bitter of sea-water; and in a few years the secret transpired, and the same was prepared from sea-water at Portsmouth, Lymington, and at Newcastle; by which the salt from the Shooter's-hill springs was underfold, and the works were abandoned. Epsom salt was for a long time only prepared in this country, and the continent was supplied from hence; on which account it became known in Europe under the name of Epsom, or English salt; but Bergman afterwards discovered the same in the Sedlitz or Seydschutz waters in Bohemia, whence the name Sedlitz salt was added to its other appellations.

A considerable confusion prevailed for a long time between this salt and Glauber's Sal Mirabile (sulphat of soda,) the acid of both being the same, and the medicinal uses of each, and comparative doses, not materially differing. In fact it appears, that sometimes the true Glauber's salt was made small grained, by stirring it as it began to crystallize; and sometimes the true Epsom salt was made large grained to imitate Glauber's; and each was occasionally passed off for the other as either happened to be in most request. This kind of fraud indeed is still practised pretty extensively on parts of the continent where the Epsom salt is not easily procured. Some chemical difference between the two salts was very soon ascertained. Dr. Grew gives it as characteristic of the Epsom salt, that it coagulates with an alkali; but the nature of the earth that forms this coagulum, was not fully understood till the researches of Black and Bergman proved it to be the earth magnesia.

Epsom salt is a highly and justly esteemed purgative medicine, and is in very constant use. The taste is salt and bitter, attended, however, with a peculiar flavour approaching to sweetness. Notwithstanding its nauseous taste, it is often found to remain on the stomach when rhubarb and most other medicines are rejected, and in general it operates speedily, effectually, and without griping or debilitating. The usual dose for an adult is from half an ounce to an ounce; but it should be pretty largely diluted in gruel, broth, or any mucilaginous liquor.

EPSTEIN, in *Geography*, a small town of Germany, formerly in the Landgraviate of Hesse Darmstadt, but since the peace of Luneville, in the territory of the princes of Nassau Dietz. It is situated at no great distance from the confluence of the Rhine and Mayn, 18 miles N.W. of Francfort on the Mayn; and is chiefly remarkable for some good iron mines in its neighbourhood.

EPTACTIS, in *Natural History*, a name given by Linkius, and some other authors, to a species of star-fish, of the astrophyte kind, whose rays, or branches, at their first going out from the body, are only seven in number; but which very soon spread into more. See *STAR-fish*.

EPTAMERIDES, in *Music*, a name given by M. Sauveur to one of the intervals of his system, inserted in the Mem. de l'Acad. des. Sc. for 1701.

This author begins by dividing the octave into 43 parts or merides, then each of these into 7 eptamerides, so that the octave entire comprehends 301 eptamerides, which he still subdivides. (See *DECAMERIDE*.) The word is formed of  $\epsilon\pi\tau\alpha$ , seven, and of  $\mu\epsilon\rho\iota\varsigma$ , a part. In Sauveur's subdivision the octave is =  $23\frac{1}{10}\Sigma + 3\frac{1}{10}\Gamma + 3\frac{1}{10}m$ : and its common logarithm is = .9989999.0035. or .9990000.0000 according to the assumption of M. Sauveur, wherein the octave = .6990000.0000 and its reciprocal .3010, &c.

EPTE, in *Geography*, a small river of France in the

department of the Eure, which has its source near Bernay, and falls into the Seine below Vernon.

EPULÆ. See ENTERTAINMENTS.

EPULARES, in *Antiquity*, an epithet given to those who were admitted to the sacred epulæ or entertainments; it being unlawful for any to be present at them who were not pure and chaste.

EPULIS, (from *επι*, upon, and *ωλα*, the gums,) in *Surgery*, a tubercle on the gums. There are two kinds; one of a benign nature, and free from pain; the other more malignant, being very troublesome, and occasionally becoming, according to the descriptions of surgical writers, of a cancerous quality. Some of the excrescences are represented as having a narrow pedicle, while others are connected with the gum by means of a broad base.

The best plan of treatment consists in extirpating an epulis, as soon as the nature of the case manifests itself. The object may be accomplished either with caustic, or the knife. The latter mode is that, to which we should generally give the preference, because attended with the greatest degree of certainty, and not more pain.

Some writers advise us to tie the excrescence, when its neck is narrow. However, in such a case, the knife, or a pair of scissars, might also be very conveniently employed.

EPULO, in *Antiquity*, the name of a minister of sacrifice among the Romans.

The pontifices, not being able to attend all the sacrifices performed at Rome, to so many gods as were adored by that people, appointed three ministers, whom they called epulones, because they conferred on them the care and management of the epulæ; feasts in the solemn games and festivals.

To them belonged the ordering and serving the sacred banquet offered on such occasions to Jupiter, &c. They wore a gown bordered with purple, like the pontifices, their number was at length augmented from three to seven, and afterwards by Cæsar to ten.

Their first establishment was in the year of Rome 558, under the consulate of L. Furius Purpureo, and M. Claudius Marcellus.

EPULOTICS, (from *επουλω* to cicatrize), in *Surgery*, topical applications, which dispose wounds and ulcers to heal.

EPULUM, in *Antiquity*, banquet, a holy feast prepared for the gods.

The statues of the gods were commonly laid upon a bed, and served in the epula, as if they had been very hungry; to perform which was the function of the ministers of sacrifice, hence called epulones.

EPWORTH, in *Geography*, a market town in Lindsey division of Lincolnshire, England, is situated 158 miles from London: it is built in a straggling irregular manner; and contains, according to the late population return, 275 houses, and 1434 inhabitants, who are chiefly employed in spinning hemp and flax, of which great quantities are grown here, and in the manufacture of sacking and bagging, which is the chief trade of the town. A weekly market is held on Thursdays, and two fairs annually. Quantities of large oaks, firs, and other trees, some of which appear to have been burnt, and others cut down, are frequently found here three feet beneath the surface of the earth. The rectory of Epworth was held by the Rev.

Samuel Wesley, the father of the distinguished leaders of the Arminian Methodists, John and Charles Wesley.

EQUABLE MOTION, is that whereby the moveable body proceeds with the same continued velocity; neither accelerated nor retarded.

EQUABLE Pulse. See PULSE.

EQUABLE Style. See STYLE.

EQUABONA, in *Ancient Geography*, a town of Spain, in Lusitania, according to the Itinerary of Antonine, situated on the left side, and at the mouth of the Tagus, not far from the sea.

EQUAL, a term of relation between two or more things of the same magnitude, quantity, or quality.

Wolffius defines equals to be those things which may be substituted for each other, without any alteration of their quantity. It is an axiom in geometry, that two things which are equal to the same third, are also equal to each other. And again, if to or from equals you add or subtract equals, the sum or remainder will be equal.

EQUAL Altitudes, in *Practical Astronomy*. One of the most practicable and certain methods of determining the time, and thus ascertaining the error of a clock or chronometer, is by observing equal altitudes of the sun, or of a fixed star. For this purpose all that is necessary is to observe the instant the sun or star is at any altitude towards the east, before the meridian passage; and the instant must likewise be marked when the same object attains exactly the same altitude towards the west, after the meridian passage: the mean between the above quantities will be the instant marked by the clock at the moment the sun or star was on the meridian. The preceding operation, however, supposes, that the declination of the object has not varied during the elapsed interval, but this with the sun seldom happens. The observation, therefore, must be corrected by a table, or by a direct calculation.

Let P (*Plate XII. Astronomy, fig. 106.*) be the elevated pole, Z the zenith, S the sun, S B an arc parallel to the horizon H O, so that the points B and S have the same altitude; P S the polar distance of the sun in the morning, P B its polar distance in the evening (supposed to have become less). When the sun in the afternoon arrives at the point B, whose altitude suppose 20°, the same as the morning, the hour angle Z P B, or the distance of the sun, and its hour angle from the meridian P Z, will be greater than the morning hour angle Z P S. We have, therefore, two triangles, Z P S, Z P B, which have each the side P Z common, and the sides Z S, Z B, each equal to 70°, since they are the complements of the altitudes, 20° in each case. The sides P S, P B, differ by a quantity which is equal to the change of the sun's declination in the interval between the two observations. If the two triangles be resolved separately, the two hour angles will be found different: the half of this difference is the correction, which must be applied to the middle point of time to obtain the exact instant of the sun's passage over the meridian. This correction is given in the annexed table, which is taken from the last edition of La Lande's *Astronomy*. It is calculated from the following differential analogy.

$$\frac{\delta \times (\text{tang. latitude} \pm \text{tang. dec. } \odot)}{30 (\text{sin. hour-angle} \pm \text{tang. hour-angle})}$$

# EQUAL.

## TABLE OF EQUATION OF EQUAL ALTITUDES.

Argument  $\frac{1}{2}$  the elapsed Time.

Sun's Long.									Sun's Long.									Log. of Diurn. Mot. in Declin.		
S. D.	1 <sup>h</sup> 40'	2 <sup>h</sup> 0'	2 <sup>h</sup> 20'	2 <sup>h</sup> 40'	3 <sup>h</sup> 0'	3 <sup>h</sup> 20'	3 <sup>h</sup> 40'	4 <sup>h</sup> 0'	S. D.	1 <sup>h</sup> 40'	2 <sup>h</sup> 0'	2 <sup>h</sup> 20'	2 <sup>h</sup> 40'	3 <sup>h</sup> 0'	3 <sup>h</sup> 20'	3 <sup>h</sup> 40'	4 <sup>h</sup> 0'			
O	0	15 <sup>h</sup> .58	15 <sup>h</sup> .80	16 <sup>h</sup> .07	16 <sup>h</sup> .39	16 <sup>h</sup> .76	17 <sup>h</sup> .19	17 <sup>h</sup> .68	18 <sup>h</sup> .24	O.	0	0 <sup>h</sup> .00	3.1529							
Sub. 10		15.28	15.50	15.76	16.08	16.44	16.86	17.35	17.90	Add 10		0.96	0.93	0.90	0.85	0.81	0.75	0.69	0.62	3.1446
20		14.60	14.81	15.06	15.36	15.71	16.11	16.57	17.10	20		1.82	1.76	1.70	1.62	1.53	1.42	1.31	1.18	3.1247
I.	0	13.52	13.72	13.95	14.23	14.55	14.92	15.35	15.84	I.	0	2.49	2.41	2.32	2.21	2.09	1.95	1.79	1.61	3.0915
Sub. 10		12.06	11.24	12.44	12.69	12.98	13.31	13.69	14.13	Add 10		2.90	2.81	2.70	2.57	2.43	2.27	2.08	1.87	3.0419
20		10.22	10.37	10.55	10.76	11.00	11.28	11.61	11.98	20		2.97	2.88	2.77	2.64	2.49	2.32	2.13	1.92	2.9701
II.	0	8.04	8.15	8.29	8.45	8.65	8.87	9.12	9.41	II.	0	2.68	2.59	2.49	2.38	2.25	2.09	1.92	1.73	2.8655
Sub. 10		5.55	5.62	5.72	5.83	5.97	6.12	6.29	6.50	Add 10		2.03	1.97	1.89	1.80	1.70	1.59	1.46	1.31	2.7044
20		2.83	2.87	2.92	2.98	3.05	3.12	3.22	3.32	20		1.09	1.06	1.02	0.97	0.92	0.86	0.79	0.71	2.4124
III.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	III.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Add 10		2.83	2.87	2.92	2.97	3.04	3.12	3.21	3.31	Sub. 10		1.09	1.06	1.02	0.97	0.92	0.85	0.78	0.71	2.4116
20		5.52	5.60	5.70	5.81	5.94	6.10	6.27	6.47	20		2.03	1.96	1.88	1.80	1.70	1.58	1.43	1.31	2.7027
IV.	0	7.99	8.11	8.24	8.41	8.60	8.82	9.07	9.36	IV.	0	2.66	2.58	2.48	2.37	2.23	2.00	1.91	1.72	2.8630
Add 10		10.15	10.30	10.47	10.68	10.92	11.20	11.52	11.89	Sub. 10		2.95	2.86	2.75	2.62	2.47	2.31	2.12	1.90	2.9669
20		11.96	12.13	12.34	12.58	12.87	13.20	13.68	14.01	20		2.87	2.78	2.68	2.55	2.41	2.25	2.06	1.86	3.0381
V.	0	13.39	13.59	13.82	14.09	14.41	14.78	15.20	15.69	V.	0	2.46	2.39	2.30	2.19	2.07	1.93	1.77	1.59	3.0873
Add 10		14.45	14.65	14.92	15.20	15.54	15.94	16.40	16.92	Sub. 10		1.80	1.74	1.68	1.60	1.51	1.41	1.29	1.66	3.1201
20		15.12	15.33	15.59	15.90	16.26	16.68	17.16	17.70	20		0.95	0.92	0.89	0.85	0.80	0.74	0.68	0.61	3.1398
VI.	0	15.40	15.62	15.89	16.20	16.57	16.99	17.48	18.04	VI.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.1479
Add 10		15.29	15.51	15.77	16.09	16.45	16.87	17.36	17.91	Add 10		0.96	0.93	0.90	0.85	0.81	0.75	0.69	0.62	3.1449
20		14.78	14.99	15.25	15.55	15.90	16.31	16.78	17.31	20		1.84	0.78	1.72	1.64	0.55	1.44	0.33	1.20	3.1300
VII.	0	13.85	14.04	14.28	14.57	14.90	15.28	15.72	16.22	VII.	0	3.55	2.47	2.38	2.27	2.14	2.00	1.83	1.65	3.1017
Add 10		12.48	12.66	12.88	13.13	13.43	13.77	14.17	14.62	Add 10		3.00	2.90	2.79	2.66	2.51	2.34	2.15	1.94	3.0567
20		10.68	10.83	11.02	11.24	11.49	11.79	12.13	12.51	20		3.10	3.01	2.89	2.76	2.60	2.43	2.23	2.00	2.9890
VIII.	0	8.46	8.59	8.73	8.90	9.11	9.34	9.61	9.91	VIII.	0	2.82	2.73	2.62	2.51	2.37	2.21	2.02	1.82	2.8880
Add 10		5.88	5.96	6.07	6.19	6.33	6.49	6.67	6.89	Add 10		2.15	2.08	2.01	1.91	1.80	1.68	1.54	1.39	2.7297
20		3.02	3.06	3.11	3.17	3.25	3.33	3.42	3.53	20		1.17	1.13	1.09	1.04	0.98	0.91	0.84	0.75	2.4399
IX.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	IX.	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sub. 10		3.02	3.06	3.12	3.18	3.25	3.33	3.43	3.54	Sub. 10		1.17	1.13	1.09	1.04	0.98	0.91	0.84	0.75	2.4406
20		5.90	5.99	6.09	6.21	6.35	6.51	6.70	6.91	20		2.15	2.09	2.01	1.92	1.81	1.69	1.55	1.39	2.7314
X.	0	8.51	8.63	8.78	8.95	9.16	9.39	9.66	9.97	X.	0	2.83	2.75	2.64	2.52	2.38	2.22	2.04	1.83	2.8903
Sub. 10		10.76	10.91	11.10	11.32	11.57	11.87	12.21	12.60	Sub. 10		3.12	3.03	2.91	2.78	2.62	2.44	2.24	2.02	2.9921
20		12.59	12.77	12.99	13.24	13.54	13.89	14.29	14.74	20		3.02	2.93	2.88	2.69	2.54	2.36	2.17	1.95	3.0603
XI.	0	13.98	14.18	14.42	14.71	15.04	15.42	15.87	16.37	XI.	0	2.57	2.49	2.40	2.29	2.16	2.01	1.85	1.66	3.1059
Sub. 10		14.93	15.14	15.40	15.71	16.06	16.47	16.95	17.49	Sub. 10		1.86	1.80	1.73	1.65	1.56	1.46	1.34	1.20	3.1345
20		15.42	15.64	15.91	16.22	16.59	17.02	17.51	18.06	20		0.97	0.94	0.90	0.86	0.81	0.76	0.70	0.63	3.1486

☞ Multiply the Tangent by the Latitude, and if it is South, change the Signs.

*Equal-Altitude Instrument*, is an instrument used in *Astronomy* for ascertaining the exact time at any place, by means of equal altitudes of any heavenly body, as observed successively at the opposite sides of the meridian. Formerly, the instrument used exclusively for this purpose was a refracting telescope of considerable length, attached to a vertical axis of motion, placed truly perpendicular to the horizon by means of a plumb-line or spirit-level, so that when the telescope had a given elevation, it might be fixed at that elevation, and describe a parallel of altitude as the vertical axis turned round; which method was equally simple and accurate, as it required no graduated circles for reading either horizontal or vertical angles; but then its utility was limited to the single operation of determining the instant when any celestial body on the western side of the meridian had the same altitude that it had at a given instant on the eastern side, and hence the intermediate instant when the said body was on the meridian, provided its declination had not sensibly altered during the interval. But in the present improved state of astronomical and nautical instruments, almost any of them will measure equal altitudes with great precision, and at the same time indicate the quantity of the altitudes observed, so that an instrument to take equal altitudes only is no longer a desideratum, and its origin and construction may now be considered as matter of curiosity, or as a link in the historical chain of astronomical instruments, but yet at the time was a link of great importance. When sir Isaac Newton presented to the observatory at Trinity college, Cambridge, an excellent pendulum clock for the use of the professor, it became a matter of great importance to have the ready means of adjusting the rate of the clock to exact time; professor Cotes, therefore, contrived an equal-altitude instrument, which was made at very little expence, and which yet fully answered its purpose. This instrument is described in Dr. Robert Smith's *Optics*, and also another, which is an improvement on it, as being at that time in the possession of the earl of Ilay. As we presume it will not be unacceptable to our readers to see how an instrument, that does not indicate any measure, will yet determine equal altitudes with accuracy, we shall give in succession brief descriptions of the two instruments we have already named, accompanied by corresponding figures.

*Professor Cotes' Equal-altitude Instrument*.—*Fig. 3. of Plate XVII. of Astronomical Instruments*, is a representation of Mr. Cotes' equal-altitude instrument, as applied in taking an observation. AB is a strong wooden axis in a vertical position about six feet long, and having the extreme ends of well-tempered steel; the superior end A has a cylindrical pivot, and the lower end a conical one, both resting in adjustable pieces of metal, that are not necessary to be described; two strong bars, CD and DE, are firmly attached to the axis, so as to form a right angle where they are united at D; in like manner two other bars are fixed together and to the axis, namely, GF and FE, making a right angle at F; and below these a thick pin Y passes quite through the axis. Near the top at T is a piece of tapped wire screwing into the axis, and supporting a plumb-line TV, which falls at the point of a fine needle inserted a little out of the centre of the thick pin Y; so that by turning this wooden pin round, the needle point may be brought into contact with the line whenever it does not touch it: the bar CD has half a dozen tapering pins or pegs turned round, inserted into holes at equal distances, or nearly so, and the bar EF has one such pin. The pin at F supports the lower end of the telescope PQ, and the upper or object end hangs by one of the six pins on the arm CD, as the elevation in any observation may require; the piece

ILKM, that carries the peg N, by which the telescope hangs, being made fast to its tube. The telescope, not being an achromatic at that time, was five feet long, and therefore required the axis of motion to be at least six feet. When the pivots of the axis were nicely adjusted with respect to east and west, and also to north and south, which was known by the plumb-line hanging in apparent contact with the needle point, during the whole of an entire revolution, then the object-end of the telescope described an exact parallel to the horizon, or parallel of altitude, and whatever bodies appeared in the centre of the eye-glass, which we suppose to have been a single one, had all equal apparent altitudes.

*The Earl of Ilay's Equal-altitude Instrument*.—The instrument said to have been in the possession of the earl of Ilay, is represented by *fig. 4. of Plate XVII.* We know not who was the maker, otherwise we should have given his name in preference. The axis *ab* is of steel squared, thirty inches long; the upper end of it, *a*, bears a sextantal arch *cd*, fixed at *a* immoveably; the telescope N is thirty inches long also, and is moveable together with its graduated semi-circle round the same point *a* as a centre of motion: this semi-circle may be fixed to the sextantal arch at any elevation of the telescope, by the finger-nuts *c* and *d*, passing through the circular aperture of the semi-circle, and screwing into the sextantal arch. Immediately under the semi-circle is a spirit-level *lm*, with screws of adjustment, and at *e* under it, the axis, for a short way down, is cylindrical, about an inch in diameter, and well-polished. The lower end of the axis is conical, and the eye-piece of the telescope has in its focus five vertical wires at equal distances, parallel to each other, and two parallel cross wires, as represented in *fig. 5.* When the instrument here described is used, its axis is let down into a stand of the shape of a long hollow parallelepiped, wanting two sides. Its other sides *f, g*, are a couple of brass plates, equal in length to the part *be* of the axis, and are screwed together edgeways, but the centre of the upper square end piece *b*, four inches square, is a round hole, just large enough to receive without touching it, and over this hole is fixed another plate with a triangular hole, concentric, one of the sides of which triangle is moveable by an adjustment screw, to make the cylinder bear alike on all sides: on the lower square, or base *i*, lies another adjustable piece, with a fine conical hole to bear the point *b* of the axis, and to adjust the axis vertical by means of its screws, as pointed out by the level. The frame, thus furnished with the instrument, is then firmly fastened to a solid pillar K, by means of a niche made in it to receive the brass plates. The axis is known to be truly perpendicular when the bubble of the level will remain in the middle of the tube during every part of an entire revolution of the axis. If the axis of this instrument were to be placed parallel to the earth's axis, and in the true meridian, its construction is equally adapted for an equatorial telescope, in which case the semi-circle would in every situation be a secondary to the equator, or would measure declinations. The cross wires in the telescope are very useful for taking five pairs of observations, from which a mean may be taken with greater accuracy than one pair of observations alone would give, and in cloudy weather will afford five chances of seeing the body at the proper instants of required altitude. For the methods of applying the corrections for equal altitudes, and of ascertaining the exact time as deduced from the observations, the reader is requested to consult our article *CHRONOMETER*, where the requisite problems are exemplified. It is scarcely necessary to add, that a common Hadley's sextant or octant is a good instrument

# EQUAL.

instrument for taking equal altitudes, provided the observer have a good artificial horizon, when his observations are taken on the land; the imperfection of the graduations being of no importance, except when the exact measure is wanted for other purposes.

**EQUAL Angles**, are those whose containing lines are inclined alike to each other; or which are measured by similar arches of their circles.

**EQUAL Arches**. See ARCH.

**EQUAL Arithmetical Ratios**, are those wherein the difference of the two less terms is equal to the difference of the two greater. See RATIO.

**EQUAL Circles**, are those whose diameters are equal. See CIRCLE.

**EQUAL Curvatures**, are such as have the same or equal radii of curvature. See CURVATURE.

**EQUAL Figures**, are those whose areas are equal, whether the figures be similar or not.

The segments of a sphere, or circle, are of an equal concavity, or convexity, when they have the same ratio, or proportion to the diameters of the spheres, or circles, whereof they are parts.

**EQUAL Geometrical Ratios**, are those whose least terms are similar, aliquot, or aliquant parts of the greater.

**EQUAL Hours**. See HOUR.

**EQUAL Hyperbolas**, are those, all whose ordinates to their indeterminate axes, are equal to each other; taken at equal distances from their vertices.

**EQUAL Solids**, are those which comprehend, or contain, each as much as the other; or whose solidities, or capacities, are equal. See SOLID.

**EQUAL Beating**, in *Music*, is said of such tempered concords as beat equally quick, or make the same number of *wa, wa, wa, wa's*, in a given space of time, when sounding. The first who mentions, or makes any use of equal-beating concords, is Dr. Robert Smith, who observes, (*Harmonics*, p. 188.) "if several imperfect consonances of the same name, as Vths, for instance, (by which the whole scale is usually tuned,) beat equally quick, they are not equally harmonious, or tempered; to make them so, the higher in the scale ought to beat as much quicker than the lower, as their bases vibrate quicker (prop. xi. cor. 2.); that is, if a Vth be a minor tone higher than another, it should beat quicker, in the ratio of 10 to 9, or (if a major tone) 9 to 8 nearly; if a IIIId higher, in the ratio of 5 to 4; if a Vth higher, in the ratio of 3 to 2; if an VIIIth higher, of 2 to 1, &c.

In schol. 2. to prop. xx., the doctor gives a table of beats to be made in fifteen seconds of time, by four successive 5ths above C respectively, in order to form a system for the common instruments with twelve notes in an octave, wherein every IIIId shall beat sharp, as fast as the Vth to the same base beats flat: let it be observed, however, that this will not be the case in the IIIIds or Vths affected by the beating notes, or resulting 5th, after this method has been pursued through eleven 5ths.

In the same table we have the number of beats for the above succession of 5ths, so calculated, that the Vths and VIths to the same base may beat equally quick, the former flat, and the latter sharp; which will give the notes of the doctor's system of equal harmony in three octaves, as far as the same can be applied on a defective or douzeave instrument. At page 220, mention is made of another equal-beating system, wherein the IIIIds and VIths to the same base beat equally quick, and which is said to approach so near to the system of equal harmony, as not to need a particular table.

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In the directions given by earl Stanhope, pages 13 and 14, of his stereotype "Principles of the Science of Tuning," for adjusting his two successive biequal 3ds, and three successive triequal quint; his lordship directs that these shall be made to beat equally quick respectively; and falls into the mistake of supposing that this would produce the equal temperament of those IIIIds and the Vths respectively, that he had previously calculated for them, by mean proportionals, for his monochord system, contrary to the demonstrations of Dr. Smith above; and in a printed "Letter to the Duke of Cumberland respecting the Stanhope Temperament," this error being persisted in, after it had been pointed out by Mr. Farey in the *Philosophical Magazine*, vol. xxvii. p. 203, it becomes necessary for us to point out (as could not be done under BIEQUAL Third, in our work), that the ratios  $\frac{4}{3}$ ,  $\frac{1}{3}$ , and  $\frac{1}{2}$ , exactly represent the notes F, b A and c respectively, when the two successive 3ds (which his lordship calls biequal) E, b A and b A c, whose ratios are  $\frac{1}{3}$  and  $\frac{1}{2}$ , make an equal number of beats in a second of time; and this number of beats, when C makes 240 complete vibrations in 1", is exactly ten times in a second. Thus we see, that there are three different intervals, called

by his lordship biequal thirds, whose ratios are  $\frac{1}{2}$ ,  $\frac{\sqrt{10}}{4}$ , and  $\frac{1}{3}$ , and their common logarithms are .8985423.5924, .8979400.0867, and .8973376.5811 respectively, or in the new notation  $206.228 \Sigma + 4f + 18 m$ ,  $207.5 \Sigma + 4f + 18 m$ , and  $208.772 \Sigma + 4f + 18 m$  nearly respectively: and there are, indeed, others which arise from the new instructions which his lordship gives in the letter to the duke of Cumberland above referred to, for tuning equally-tempered concords by means of the *absence* of "beating between the two beatings;" which new species of equal beating is considered in the *Philosophical Magazine*, vol. xxxiii. p. 297, and is shewn to produce other intervals than the above, and which yet come under the appellation of biequal thirds, as desired by earl Stanhope.

**EQUAL Harmony**, has been applied by Dr. Robert Smith to the different concords V, VI, and III, (or their complements 4th, 3d, and 6th,) when they are so tempered, as to be equally harmonious or pleasant to the ear, as tempered concords; and the result of his laborious calculations for forming a system, wherein every concord within the compass of three octaves shall be equally and the most harmonious, (*Harmonics*, p. 140.) is, that each V, VI, and III, are to be tempered  $\frac{-5}{18}$ ,  $\frac{+3}{18}$ , and  $\frac{-2}{18}$  parts of a major comma respectively: or, in a system of four octaves of equally harmonious concords, these temperaments are to be  $\frac{-11}{40}$ ,  $\frac{+7}{40}$ , and  $\frac{-4}{40}$  parts of a comma for the V, VI, and III, respectively. But it is to be observed, that these temperaments are applicable only to instruments with 21 strings, or pipes, in each octave, and not to the common piano-fortes, organs, &c. in use, with only 12 strings, or pipes, of different pitches within the compass of an octave.

The term equal harmony has been, as we think, improperly applied by Mr. Emerson, and others, to the *isotonic* or *equal temperament* system of intervals (which see); it being observable that Dr. Smith's design is to effect an equal harmony among the different concords, and the equal temperament makes an equal harmony among the different keys, which are in effect very different systems, and ought not to bear the same name.

Equal harmony also denotes the tuning by perfect 5ths without temperament, making all the keys participate equally

equally of the imperfection of the scale on keyed instruments. By this method of tuning, the thirds will, at first, seem very harsh and crude; but by a little use the ear will accommodate itself to the evil, and indulge the abbé Rousfier, or his makes, with the triple progression, by which Pythagoras formed the scale, and by which the Chinese, in the most remote antiquity, according to Pere Amiot, produced the few sounds with which their imperfect scale is furnished. See TEMPERAMENT and TRIPLE Progression.

EQUAL Temperament, is a system of twelve intervals within an octave, all equal to each other; each of which

has the ratio of  $\sqrt[12]{2} = 512 + f + 412^5 m$ , (see Philosophical Magazine, vol. xxix. p. 347.) the common logarithm of each of such mean semitones being = .9749141.6703. This system is often called the isotonic, and sometimes that of Merlennus, by M. Couperin, M. Marpurg, Mr. Emerson, Mr. Cavallo, Mr. Davis, and others, who have written in its favour. Dr. Robert Smith, who disapproves of this system, states the temperaments of its V and 4th, its VI and 3d, and its III and 6th, to be  $\frac{7}{8}$ ,  $\frac{7}{8}$ , and  $\frac{6}{7}$  parts of a major comma respectively (Harmonics, p. 167.), but these are incorrect, and ought to have been  $\frac{1}{17}$ ,  $\frac{1}{17}$ , and  $\frac{6}{17}$  of a comma, the temperaments of these concords, very nearly, as stated in the first column of Tab. II. page 158, of the same work. Mr. Emerson, in his "Algebra," prob. ccii. calculates the beats which the concords in this system make, in the octave above the G of the bass clef, and states these at - 15, + 11, + 1, - 1, - 18, and + 13 in one second of time, made by the 3d, III, 4th, V, 6th, and VI respectively, the flat temperaments being marked - and the sharp ones +.

The equal temperament of Mr. Farey, (Philosophical Magazine, vol. xxviii. p. 65, and xxx. p. 6.) differs only in an insensible degree from the above, his half note being  $512 + f + 5m$  between the notes C and b D, b E and E, F and b G, G and b A, and b B and B; and  $512 + f + 4m$  between the notes b D and D, D and b E, E and F, b G and G, b A and A, A and b B, and B, &c.; yet this very slight variation enables an organ tuner to tune the twelve notes of this system, by help of certain combinations of perfect Vths, 4ths, and IIIs! In this method of obtaining an equal temperament, the successive 5ths C G, G D, D A, A E, E B, B b G, G b D, and D b A, are to be tuned upwards, each by ascending (on a spare range of pipes or different stop to the one intended to be tuned) five successive perfect 4ths, and from the highest note of these descending two perfect 5ths and one major 3d, which last or lowest note is to be transferred to the G of the stop intended to be tuned. From this same note, G, five 4ths up, and two V + III down, are to be tuned to get D, and so on to b A. The remaining 5ths c F, F b B, and b B b E, are to be tuned downwards, by descending from c five successive 4ths, and thence ascending two Vths and a III to obtain F, from which note, repeating the same process until the note b E is obtained; when, if the operations have been carefully performed, and no beats suffered to remain in any of the perfect 4ths, 5ths, 3ds, or unisons, or in the octave C c, &c. the resulting 5th, or that between the beating notes b A and b E, will be found, but in an almost insensible degree flatter than all the other fifths in the scale; the difference being only m, or less than  $\frac{1}{1300}$ th part of a major comma! between this V and each of the other eleven Vths: this being  $3572 + 7f + 30m$ , and each of the others  $3752 + 7f + 31m$ . The logarithm of the first or largest of the half-notes in this system is = .9749119.1920, and of the smallest .9749157.7262. See TEMPERAMENT.

EQUAL, in Optics. We say, that things seen under equal angles are equal. Equal parts of the same interval, or magnitude, if unequally distant from the eye, appear unequal. Equal objects, and at equal distances, only the one placed directly, and the other obliquely, seem unequal; and that placed directly, the bigger.

Masonry by EQUAL Courses. See MASONRY.

EQUALITY, in Algebra, is a comparison of two quantities, that are equal both really and representatively, i. e. which are so both in effect and letters.

A comparison of two quantities equal in effect, but unequal in letters, to render them equal, is called an equation, which see.

EQUALITY is usually denoted by two parallel lines, as = : thus  $2 + 2 = 4$ , i. e. 2 plus 2 are equal to 4. This character was first introduced by Robert Recorde. Des Cartes, and some after him, in lieu thereof, use  $\propto$ : thus,  $2 + 2 \propto 4$ ; so  $z - y \propto b + c$ ; signifies that z minus y is equal to b plus c.

From an equation we arrive at an equality, by changing an unknown letter into another, whereby the two members of the equation, i. e. the two quantities compared together, and connected by the sign of equality, are rendered equal.

Thus, in the equation  $a x = b c d$ ; supposing  $x = \frac{bcd}{aa}$ , we change x into  $\frac{bcd}{aa}$ , and by this substitution arrive at the equality  $bcd = bcd$ .

In the solution of a numerical problem, which is to be rendered rational, if there be only one power to be equalled to a square, or other higher power, it is called simple equality.

Where there are two powers to be equalled, each to a square, it is called double equality, &c.

Diophantus hath given us a method for double equalities, and F. de Billy, another for triple equalities, in his Diophantus Redivivus.

EQUALITY, in Astronomy. Circle of EQUALITY, or the equant. See CIRCLE and EQUANT.

EQUALITY denotes the exact agreement of two or more things in respect of quantity. Thus, figures are equal which may occupy the same space, by the fluxion or transposition of their parts. See on this subject an elaborate dissertation by Dr. Barrow, in the 11th and 12th of his Mathematical Lectures.

EQUALITY, ratio, or proportion of, in Geometry, is that between two equal numbers, or quantities.

Proportion of EQUALITY evenly ranged, or ex aequo ordinata, is that in which two terms in a rank, or series, are proportional to as many terms in another series, compared to each other in the same order, i. e. the first of one rank to the first of another; the second to the second, &c.

Proportion of EQUALITY evenly disturbed, called also ex aequo perturbata, is that in which more than two terms of one rank are proportional to as many terms of another compared to each other, in a different and interrupted order; viz. the first of one rank to the second of another; the second to the third, &c.

EQUALITY, Union of. See UNION.

EQUALITY, in Law, the law delights in equality; so that when a charge is laid upon one, and divers ought to bear it, he shall have relief against the rest. 2 Rep. 25.

EQUANIMITY, in Ethics, denotes an even, uniform temper of mind, amidst all the varieties and revolutions of time and chance. This virtue, together with prudence, forms the character which Horace gives of Aristippus:

"Omnis

“Omnis Aristippum deceit color & status & res.”

**EQUANT, or ÆQUANT,** in *Astronomy*, a circle, formerly imagined by astronomers, in the plane of the deferent, or eccentric; for regulating and adjusting certain motions of the planets, and reducing them more easily to a calculus. See **APOGEE, CIRCLE, DEFERENT, and EXCENTRIC.**

**EQUATED ANOMALY.** See **ANOMALY** and **ELLIPTIC Motion.**

**EQUATED Bodies.** On Gunter's sector there are sometimes placed two lines, answering to one another, and called the lines of equated bodies: they lie between the lines of solids, and superficies, and are noted with the letters D, I, C, S, O, T, for dodecahedron, icosaedron, cube, sphere, octahedron, and tetrahedron.

The uses of these lines are, 1. When the diameter of the sphere is given, to find the sides of the five regular bodies, severally equal to that sphere. 2. From the side of any of the bodies being given, to find the diameter of the sphere, and the sides of the other bodies, which shall be equal severally to the first body given.

If the sphere be first given, take its diameter, and apply it over in the sector in the points S, S: if any of the bodies be first given, apply the side of it over in its proper points; so the parallels taken from between the points of the other bodies shall be the sides of those bodies, equal severally to the first body given.

**EQUATION,** in *Algebra*, is when two equal quantities, differently expressed, are compared together, by means of the sign = placed between them.

Thus,  $9 - 4 = 5$ , is an equation expressing the equality of  $9 - 4$  and  $5$ ; and  $a + b - c = d$ , is an equation denoting that the difference between the sum of  $a + b$ , and  $c$ , is equal to  $d$ ; the quantities between which the sign = is placed being called the two sides of the equation.

It is sometimes customary, however, to place all the quantities on one side of the equation, and to make them equal to 0, or zero, on the other side; as  $a - b = c$ , or  $a + b - c = 0$ , &c. which is only setting down the difference of two equal quantities and putting it equal to 0.

The terms of an equation, are the several quantities or parts of which it is composed: thus, in the equation  $a + b = c$ , the terms are  $a$ ,  $b$ , and  $c$ ; and the sense or meaning of the expression is, that some quantity represented by  $c$ , is equal to the sum of two others, represented by  $a$  and  $b$ .

When a quantity stands alone, on one side of an equation, the terms on the other side are said to be a value of that quantity. Thus, in the equation  $x = a - b$ , the difference of the two numbers represented by  $a$  and  $b$  is called the value of  $x$ .

Equations are also distinguished by the denominations of *simple* and *compound*, or, as they are frequently called, *simple* and *affected*; which latter term, however, it would be better to discard, as being less natural and appropriate than that of *compound*.

A *simple equation*, is that which contains only one power of the unknown quantity; as  $x + a = b$ , or  $a x^2 + b = c$ , or  $2 x^3 + 3 a^2 = 4 b$ , &c. where  $x$  denotes the unknown quantity, and the other letters or figures such quantities as are known.

A *compound equation*, is that which contains two or more powers of the unknown quantity; as  $x^2 + a x = b$ , or  $x^3 + a x^2 - b x = c$ , &c.

Equations are likewise divided into different orders, according to the highest power of the unknown quantity contained in any one of their terms; as *quadratic*, *cubic*, *biquadratic*, &c. thus,

A *quadratic equation*, is that in which the unknown quantity rises to two dimensions, or that contains both the unknown quantity and its square; as  $x^2 + 10 x = 30$ , or  $a x^2 + b x = c$ .

A *cubic equation*, is that in which the unknown quantity is of three dimensions, or that rises to the cube or third power; as  $x^3 - 3 x = 1$ , or  $x^3 + 2 x^2 = 4$ , or  $a x^3 + b x^2 + c x = d$ .

A *biquadratic equation*, is that in which the unknown quantity is of 4 dimensions, or that rises to the fourth power; as  $x^4 + 2 x = 5$ , or  $x^4 + 3 x^2 = 10$ , or  $x^4 + 4 x^2 + 7 x = 50$ , or  $a x^4 + b x^3 + c x^2 + d x = e$ . And so on, for the 5th, 6th and other higher order of equations; which are all denominated according to the highest power of the unknown quantity contained in any one of their terms.

The *root of an equation*, is that quantity, whether positive, negative, or even imaginary, that when substituted for the unknown quantity, will make both sides of the equation vanish, or become equal to 0.

Thus, in the equation  $x^2 - 6 x = 72$ , either  $+ 12$  or  $- 6$  is a root, or value, of the unknown quantity; for if each of these numbers be separately substituted for  $x$ , they will be found to satisfy the conditions of the equation.

In the resolution of an equation, containing only one unknown quantity, several previous operations are often required to be performed, in order to adapt it to the rule to which it belongs; the greater part of which may be performed by means of a few self-evident and obvious principles; namely, that if equal quantities be added to, or subtracted from, equal quantities, the sums or remainders will be equal; if equal quantities be multiplied or divided by the same quantity the products or quotients will be equal; or if equal quantities be raised to the same power, or have the same root extracted, the results will still be equal.

From these simple considerations are derived the following rules, which will equally apply to equations of all orders, and are alone sufficient for the resolution of simple equations.

**Rule 1.**—Any quantity may be transposed from one side of the equation to the other by changing its sign.

Thus, if  $x - 5 = 8$   
Then  $x = 8 + 5$   
Or  $x = 13$   
And if  $4 x - 8 = 3 x + 7$   
Then  $4 x - 3 x = 7 + 8$   
Or  $x = 15$

From this rule it also follows that if any quantity be found on each side of the equation, with the same sign, it may be left out of both. And that the signs of all the terms of an equation may be changed into the contrary ones, without affecting the truth of the equation.

Thus, if  $x + 2 = 7 + 2$   
Then  $x = 7$   
And if  $a - x = b - c$   
Then  $x + a = c - b$   
Or  $x = a + c - b$

**Rule 2.**—If the unknown quantity, in an equation, be multiplied by any quantity, that quantity may be taken away, by dividing all the rest of the terms by it.

Thus, if  $7 x = 49$   
Then  $x = \frac{49}{7} = 7$   
And if  $a x = b - c$   
Then  $x = \frac{b - c}{a}$

**Rule 3.**—If any term of an equation be a fraction, its denominator

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nominator may be taken away, by multiplying all the rest of the terms by it.

$$\text{Thus, if } \frac{x}{2} = 3$$

$$\text{Then } x = 6$$

$$\text{And if } \frac{x}{u} - b = c$$

$$\text{Then } x - ab = ac$$

$$\text{Or } x = a(b + c)$$

Or the denominators may be taken away from several terms of an equation, by one operation, if all the terms be multiplied by any number which is a multiple of each of the denominators.

$$\text{Thus, if } \frac{x}{2} + \frac{x}{3} + \frac{x}{4} = 6$$

Then, if all the terms be multiplied by 12, which is a multiple of 2, 3 and 4,

$$\text{We shall have } 6x + 4x + 3x = 72$$

$$\text{And } 13x = 72$$

$$\text{Or } x = \frac{72}{13} = 5 \frac{7}{13}$$

It also appears, from this rule, that if each of the terms of an equation be either multiplied or divided by the same quantity, that quantity may be left out of them all.

$$\text{Thus, if } ax = ab + ac$$

$$\text{Then } x = b + c$$

$$\text{And if } \frac{x}{a} + \frac{b}{a} = \frac{c}{a}$$

$$\text{Then } x + b = c$$

$$\text{Or } x = c - b$$

4. If the unknown quantity, in any equation, be in the form of a surd, let it be made to stand alone on one side of the equation, and the remaining terms on the other; then involve each side to a power denoted by the index of the surd, and the quantity will thus be rendered free from any surd expression.

$$\text{If, for example, } \sqrt{x + 2} = 5$$

$$\text{Then, by transposition, } \sqrt{x} = 5 - 2 = 3$$

$$\text{And, by squaring both sides, } x = 9$$

$$\text{In like manner, if } \sqrt{x^2 + a} - x = b$$

$$\text{Then, by transposition, } \sqrt{x^2 + a} = b + x$$

$$\text{And by squaring } x^2 + a = b^2 + 2bx + x^2$$

$$\text{And by leaving out } x^2 \text{ on each side } a = b^2 + 2bx$$

$$\text{Or } a - b^2 = 2bx$$

$$\text{Or } x = \frac{a - b^2}{2b}$$

5. Any analogy, or proportion, may be converted into an equation, by making the product of the two extremes equal to that of the two means.

$$\text{Thus, if } 3x : 16 :: 5 : 7$$

$$\text{Then } 3x \times 7 = 16 \times 5$$

$$\text{Or } 21x = 80$$

$$\text{Or } x = \frac{80}{21} = 3 \frac{17}{21}$$

Having thus shewn the manner in which a simple equation, containing only one unknown quantity, may be solved, it will be proper, in the next place, to explain the methods by which two or more equations of this kind may be reduced to a single one, and thence resolved by some of the foregoing rules; observing, in this case, that there must always be the same number of equations as there are unknown quantities, otherwise the question will admit of a variety of answers.

The principal methods, made use of for this purpose, as far as regards the resolution of two simple equations, are the three following:

1. Observe which of the unknown quantities is the least involved, and find its value in each of the two equations by the methods already explained.

This being done, let the values, thus found, be put equal to each other; and there will arise a new equation, with only one unknown quantity in it, the value of which may be found as before.

As an example in this case, let it be required to determine  $x$  and  $y$  from the two following equations.

$$2x + 3y = 23$$

$$5x - 2y = 10$$

$$\text{Then, from the 1st equation } x = \frac{23 - 3y}{2}$$

$$\text{And from the 2d, } x = \frac{10 + 2y}{5}$$

Hence, if these two values be put equal to each other,

$$\text{We shall have } \frac{10 + 2y}{5} = \frac{23 - 3y}{2}$$

$$\text{Or } 20 + 4y = 115 - 15y$$

$$\text{Therefore } 15y + 4y = 115 - 20$$

$$\text{Or } 19y = 95$$

$$\text{And consequently } y = \frac{95}{19} = 5$$

$$\text{And } x = \frac{10 + 2y}{5} = \frac{10 + 10}{5} = \frac{20}{5} = 4$$

2. Consider which of the unknown quantities you would first exterminate, and find its value in that equation where it is the least involved.

Then substitute this value for its equal in the other equation, and there will arise a new equation, with only one unknown quantity in it, the value of which may be found as before.

Thus, taking the same example as in the former rule.

$$2x + 3y = 23$$

$$5x - 2y = 10$$

$$\text{Then, from the 1st equation, } x = \frac{23 - 3y}{2}$$

And, if this value be substituted for  $x$  in the 2d equation, we shall have

$$5\left(\frac{23 - 3y}{2}\right) - 2y = 10$$

$$\text{Or } 115 - 15y - 4y = 20$$

$$\text{And consequently } 115 - 20 = 15y + 4y$$

$$\text{Or } y = \frac{95}{19} = 5$$

$$\text{And } x = \frac{23 - 3y}{2} = \frac{23 - 15}{2} = \frac{8}{2} = 4$$

3. Let the given equations be multiplied or divided by such numbers or quantities as will make the term which contains one of the unknown quantities the same in both equations.

Then, by adding or subtracting the two equations, as occasion may require, there will arise a new equation with only one unknown quantity in it, which may be resolved as before.

Thus, taking the same example as in the two former methods.

$$2x + 3y = 23$$

$$5x - 2y = 10$$

Then, to exterminate  $x$ , let the first equation be multiplied by 5, and the 2d by 2, and we shall have

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$$10x + 15y = 115$$

$$10x - 4y = 20$$

And subtracting the latter of these two equations from the former, the result will be

$$19y = 95$$

And consequently  $y = \frac{95}{19} = 5$

And if this be substituted for  $y$  in the last of the two given equations, we shall have

$$5x - 2 \times 5 = 10$$

$$\text{Or } 5x = 10 + 10 = 20$$

$$\text{Or } x = \frac{20}{5} = 4$$

As another example of this third method, which is commonly more easy and expeditious in practice than either of the other two,

Let there be given  $\begin{cases} ax + by = c \\ dx + fy = g \end{cases}$  to find  $x$  and  $y$

Then, in order to exterminate  $y$ , let the first equation be multiplied by  $f$ , and the second by  $b$ , and we shall have

$$afx + bfy = cf$$

$$bdx + bfy = bg$$

And by taking the difference of these two equations, there will arise

$$afx - bdx = cf - bg$$

$$\text{Or } (af - bd)x = cf - bg$$

$$\text{And consequently } x = \frac{cf - bg}{af - bd}$$

In like manner, if the first of the two given equations be multiplied by  $d$ , and the second by  $a$ , we shall have

$$adx + bdy = cd$$

$$adx + afy = ag$$

And, the difference of these equations being taken as before, will give

$$bdy - afy = cd - ag$$

$$\text{Or } (bd - af)y = cd - ag$$

$$\text{And consequently } y = \frac{cd - ag}{bd - af}$$

In which case,  $x$  and  $y$  are here found in general terms; and consequently the solution will hold true, whatever numbers may be substituted for  $a, b, c, d, e, f$ , and  $g$ .

If it be required to exterminate three unknown quantities, or to reduce the three simple equations containing them to a single one, it may be done as follows:

Find the value of one of the three unknown quantities in each of the three simple equations containing it; then compare the first of these values with the second, and the second with the third, and there will arise two new equations, containing only two unknown quantities, the values of which may be found by either of the former rules.

Let there be given, for example, the three following equations, to find  $x, y$ , and  $z$ .

$$x + y + z = 53$$

$$x + 2y + 3z = 105$$

$$x + 3y + 4z = 134$$

Then, if  $x$  be exterminated in each of these equations, we shall have,

$$x = 53 - y - z$$

$$x = 105 - 2y - 3z$$

$$x = 134 - 3y - 4z$$

And by comparing the first of these with each of the other two, there will arise the two following equations:

$$53 - y - z = 105 - 2y - 3z$$

$$53 - y - z = 134 - 3y - 4z$$

From which, by transposition, and the rules of addition and subtraction, we shall readily find,

$$y = 52 - 2z$$

$$y = \frac{81 - 3z}{2}$$

And consequently, by equating these two values of  $y$ , we shall obtain,

$$\frac{81 - 3z}{2} = 52 - 2z$$

$$\text{Or } 81 - 3z = 104 - 4z$$

$$\text{Or } 4z - 3z = 104 - 81 = 23$$

Hence  $z = 23$

$$y = 52 - 2z = 52 - 46 = 6$$

$$x = 53 - y - z = 53 - 6 - 23 = 24$$

And if the three following equations be proposed, in general terms,

$$ax + by + cz = d$$

$$a'x + b'y + c'z = d'$$

$$a''x + b''y + c''z = d''$$

Then the values of  $x, y$ , and  $z$ , found in a similar manner, will be as below:

$$z = \frac{ab'd'' - ad'b'' + da'b'' - bad'' + bd'a'' - db'a''}{ab'c'' - ac'b'' + ca'b'' - ba'c'' + bc'a'' - cb'a''}$$

$$y = \frac{ad'e'' - ac'd'' + ca'd'' - da'e'' + dc'a'' - cd'a''}{ab'c'' - ac'b'' + ca'b'' - ba'c'' + bc'a'' - cb'a''}$$

$$x = \frac{db'e'' - dc'b'' + cd'b'' - bd'e'' + bc'd'' - cb'd''}{ab'c'' - ac'b'' + ca'b'' - ba'c'' + bc'a'' - cb'a''}$$

Where, if any numbers whatever be substituted in the place of the literal coefficients, the equation will hold: and in a manner analogous to this, we may exterminate four or more unknown quantities in general terms; and thence, by substitution, determine their values in any numeral equations that may be proposed.

Having thus sufficiently shewn the method of solving simple equations, it will next be proper to proceed to the resolution of quadratic equations, or those of the second power, which, omitting the simple case  $x^2 = a$ , and confining ourselves only to such as are compound, may always be reduced to one of the three following forms:

$$1. x^2 + ax = b$$

$$2. x^2 - ax = b$$

$$3. x^2 - ax = -b$$

Where the value of the unknown quantity  $x$ , in each of the equations, taken according to the order in which they stand, may be exhibited as below:

$$1. x = -\frac{a}{2} \pm \sqrt{\frac{a^2}{4} + b}$$

$$2. x = +\frac{a}{2} \pm \sqrt{\frac{a^2}{4} + b}$$

$$3. x = +\frac{a}{2} \pm \sqrt{\frac{a^2}{4} - b}$$

Or the general equation  $ax^2 \pm bx = \pm c$ , which comprehends all the three cases above-mentioned, may be resolved by means of the following rule:

Transpose all the terms that involve the unknown quantity to one side of the equation, and the known quantities to the other; observing to arrange them so, that the term which contains the square of the unknown quantity may be positive, and stand first in the equation.

Then, if the square of the unknown quantity have any coefficient prefixed to it, let all the rest of the terms be divided by it, so that the coefficient of the square of the unknown quantity may be 1.

This

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This being done, add the square of half the coefficient of the unknown quantity itself to both sides of the equation, and the side which involves the unknown quantity will now be a complete square.

Lastly, extract the square root of both sides of the equation, by which means it will be reduced to a simple one; and if the unknown quantity be made to stand alone, on one side of the equation, and the known terms on the other, its value will be determined as was required.

*Note.* The square root of the first side of the equation is always equal to the sum or difference of the unknown quantity, and half the coefficient of the second term, according as that term is + or -.

It may also be observed, that all equations, in which there are two terms involving the unknown quantity, and which have the index of the one just double that of the other, are solved like quadratics, by completing the square.

Thus,  $x^4 - ax^2 = b$ , or  $x^{2n} - ax^n = b$ , are the same as quadratics; their roots being as below.

$$x = \sqrt{\frac{a}{2} \pm \sqrt{\frac{a^2}{4} + b}}, \quad x = \sqrt[n]{\frac{a}{2} \pm \sqrt{\frac{a^2}{4} + b}}$$

As an illustration of the rule for quadratics given above, the following simple examples in numbers will be found sufficient.

1. Given  $x^2 + 4x = 140$ , to find  $x$ .

Here  $x^2 + 4x + 4 = 140 + 4 = 144$ , by completing the square.

And  $\sqrt{x^2 + 4x + 4} = \sqrt{144}$ , by extracting the root. Or, which is the same thing,  $x + 2 = 12$ .

And consequently  $x = 12 - 2 = 10$ .

2. Given  $x^2 - 6x + 8 = 80$ , to find  $x$ .

Here  $x^2 - 6x = 80 - 8 = 72$ , by transposition.

Then  $x^2 - 6x + 9 = 72 + 9 = 81$ , by completing the square.

And  $x - 3 = \sqrt{81} = 9$ , by extracting the root.

Whence  $x = 9 + 3 = 12$ .

3. Given  $2x^2 + 8x - 20 = 70$ , to find  $x$ .

Here  $2x^2 + 8x = 70 + 20 = 90$ , by transposition.

Then  $x^2 + 4x = 45$ , by dividing by 2.

And  $x^2 + 4x + 4 = 45 + 4 = 49$ , by completing the square.

Whence  $x + 2 = \sqrt{49} = 7$ , by extracting the root.

And consequently  $x = 7 - 2 = 5$ .

4. Given  $\frac{x^2}{2} - \frac{x}{3} + 20\frac{1}{2} = 42\frac{1}{2}$ .

Here  $\frac{x^2}{2} - \frac{x}{3} = 42\frac{1}{2} - 20\frac{1}{2} = 22\frac{1}{6}$ , by transposition.

And  $x^2 - \frac{2}{3}x = 44\frac{1}{3}$ , by dividing by  $\frac{1}{2}$ , or multiplying by 2.

Whence  $x^2 - \frac{2}{3}x + \frac{1}{9} = 44\frac{1}{3} + \frac{1}{9} = 44\frac{4}{9} = 49\frac{0}{9}$ , by completing the square.

And  $x - \frac{1}{3} = \sqrt{49\frac{0}{9}} = \frac{7}{3}$ .

Therefore  $x = \frac{7}{3} + \frac{1}{3} = \frac{8}{3} = 2\frac{2}{3}$ .

It must here, however, be observed, that since the square root of any quantity may be either positive (+) or negative (-), it follows that all quadratic equations will admit of two solutions. Thus, the square root of  $a^2$  (or  $\sqrt{a^2}$ ) is either  $+a$  or  $-a$ ; for  $(+a) \times (+a)$  or  $(-a) \times (-a)$  are each equal to  $a^2$ , by the rules for the signs in multiplication. So, in like manner, if there be given  $x^2 + ax = b$ ,

where  $x + \frac{a}{2}$  is found  $= \sqrt{b + \frac{1}{4}a^2}$ , the root may be +

$\sqrt{b + \frac{1}{4}a^2}$ , or  $-\sqrt{b + \frac{1}{4}a^2}$ , since either of them being multiplied by itself will produce  $b + \frac{1}{4}a^2$ . And this ambiguity is usually expressed by writing the uncertain sign  $\pm$  before  $\sqrt{b + \frac{1}{4}a^2}$ , by which means we have  $x = \pm \sqrt{b + \frac{1}{4}a^2} - \frac{1}{2}a$ ; and the same mode of reasoning is equally applicable to any literal or numeral quadratic equation whatever. Thus, in the first numeral equation above,  $x^2 + 4x = 140$ , it has been found that  $x + 2 = \sqrt{144} = 12$ ; but if the uncertain sign  $\pm$  be put before  $\sqrt{144}$ , it will become  $x + 2 = \pm \sqrt{144} = +12$  or  $-12$ ; and consequently  $x = +12 - 2 = 10$  or  $-12 - 2 = -14$ , which are the two roots of the equation  $x^2 + 4x = 140$ , as will be found by substituting either of them for  $x$ ; the result in both cases being 144.

In addition to this, it may be still farther remarked, that a quadratic equation may be proposed of such a form, or have its coefficients so related to each other, that the value of the unknown quantity can only be exhibited by means of the square root of a negative quantity, which, it is plain, cannot be determined; as there is no quantity, either positive or negative, which being multiplied by itself produces such a form of expression. If, for example, the value of  $x$  were required from the equation  $x^2 + 13 = 4x$ , or  $x^2 - 4x = -13$ , we should find  $x = 2 \pm \sqrt{-9}$ ; and as it is here necessary to extract the square root of  $-9$ , which cannot be determined, the question is shewn to be impossible, or to involve a contradiction.

But although imaginary expressions of this kind are of no other use in the resolution of quadratic equations, than to shew that a particular problem cannot be solved, they must not, on this account, be altogether rejected; as they are well known to be of the greatest use in many mathematical investigations, particularly in some of the higher branches of the science, where no other mode of reasoning could be so successfully or advantageously employed.

Thus, if  $e$  be made to represent the number of which the hyperbolic logarithm is 1, it is well known, as a theorem in trigonometry, that

$$\text{Cos. } x = \frac{e^x \sqrt{-1} + e^{-x} \sqrt{-1}}{2}$$

$$\text{Sin. } x = \frac{e^x \sqrt{-1} - e^{-x} \sqrt{-1}}{2 \sqrt{-1}}$$

Where the sine and cosine of any arc  $x$  is exhibited in a very commodious manner, by means of imaginary exponential expressions; which formulæ, though objected to, and ridiculed by certain writers, are considered, by the celebrated Lagrange (*Leçons, sur des Fonct. Analytiques*) as one of the finest analytical discoveries of the eighteenth century.

Having thus sufficiently explained the nature of quadratic equations, it will be necessary, before we proceed to the resolution of cubics and those of higher dimensions, to shew, how the second term of any equation may be taken away, in order to fit it for a solution; which is done as follows:

Divide the coefficient of the second term of the proposed equation by the exponent of the first term, and add the quotient, with its sign changed, to some new unknown quantity: then if this sum be substituted for the unknown quantity in the proposed equation, a new equation will arise, which will want the second term, as required.

For example, let the quadratic equation  $x^2 - 8x + 15 = c$ , be that of which it is required to take away its second term.

Then since  $\frac{8}{2} = 4$ , if  $x$  be put  $= y + 4$ , we shall have,

$$x^2 =$$

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$$\begin{aligned} x^2 &= y^2 + 8y + 16 \\ - 8x &= - 8y - 32 \\ + 15 &= + 15 \end{aligned}$$

Whence  $y^2 - 1 = 0$ , the equation required.

From which it appears, that any quadratic equation may be solved without completing the square, by only taking away the second term; for since in the above reduced equation  $y = \sqrt{1} = 1$ , we shall have  $x = y + 4 = 1 + 4 = 5$ .

Again, let the equation  $x^3 - 9x^2 + 26x - 34 = 0$  be given, to exterminate the second term.

Then since  $\frac{9}{3} = 3$ , if  $x$  be put  $= y + 3$ , we shall have,

$$\begin{aligned} x^3 &= y^3 + 9y^2 + 27y + 27 \\ - 9x^2 &= - 9y^2 - 54y - 81 \\ + 26x &= + 26y + 78 \\ - 34 &= - 34 \end{aligned}$$

Whence  $y^3 - y - 10 = 0$ , or  $y^3 - y = 10$ , the equation required.

In like manner, let the following literal equations of the fourth power  $x^4 + px^3 + qx^2 + rx + s = 0$  be given, to exterminate the second term.

Then, by putting  $x = y - \frac{p}{4}$ , we shall have,

$$\begin{aligned} x^4 &= y^4 - py^3 + \frac{3p^2}{8}y^2 - \frac{p^3}{16}y + \frac{p^4}{256} \\ px^3 &= + py^3 - \frac{3p^2}{4}y^2 + \frac{3p^3}{16}y - \frac{p^4}{64} \\ qx^2 &= + qy^2 - \frac{pq}{2}y + \frac{qp^2}{16} \\ rx &= + ry - \frac{rp}{4} \\ s &= + s \end{aligned}$$

Hence  $y^4 + \frac{8q - 3p^2}{8}y^2 + \frac{8r - 4pq + p^2}{8}y + \frac{256s - 64rp + 16qp^2 - 4p^3 + p^4}{256} = 0$ , the reduced

equation required. And the same method of solution may be applied to the taking away the second term of any equation whatever.

Another species of transformation, of use in reducing equations to their simplest form, is that of converting such of the terms as have fractional coefficients into others that shall be integral; which is done by substituting a new unknown quantity, divided by the product of all the denominators, instead of the unknown quantity in the equation; and then, by proper reductions, the equation will be found to have the form required.

Thus, let  $x^4 + \frac{p}{a}x^3 + \frac{q}{b}x^2 + \frac{r}{c}x + \frac{s}{d} = 0$ , be the given equation.

Then, if  $x$  be assumed  $= \frac{y}{abcd}$ , we shall have, by substitution,

$$\frac{y^4}{a^4b^4c^4d^4} + \frac{py^3}{a^3b^4c^4d^4} + \frac{qy^2}{a^2b^4c^4d^4} + \frac{ry}{abc^4d^4} + \frac{s}{d} = 0.$$

And by multiplying the whole equation by  $a^4b^4c^4d^4$  it will become

$$y^4 + bcdy^3 + a^2bcd^2qy^2 + abc^2d^3ry + a^4b^4c^4d^4s = 0,$$

which is of the form required.

This preparation being made, it will now be proper to proceed to the solution of *cubic equations*, or those of which the highest power is of three dimensions; all of which, when expressed in general terms, are of the form

$$x^3 \pm px^2 \pm qx \pm r = 0.$$

Or, if the second term be taken away, by means of the above-mentioned rule, any equation of this kind may be exhibited under the form

$$x^3 \pm px = \pm q$$

And, in this case, the value of the unknown quantity  $x$ , according to the rule usually ascribed to Cardan, is as follows:

$$x = \sqrt[3]{\frac{1}{2}q + \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}} + \sqrt[3]{\frac{1}{2}q - \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}}$$

Or  $x = \sqrt[3]{\frac{1}{2}q + \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}} - \sqrt[3]{\frac{1}{2}q + \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}}$  the values of  $p$  and  $q$  being always supposed to be taken with the sign  $+$  or  $-$  according as they are found in the given equation.

The rule may be demonstrated thus:

Let the equation, whose root is to be determined, be

$$x^3 + px = q$$

Then if  $x$  be assumed  $= y + z$ , we shall have, by substitution,

$$\begin{aligned} x^3 &= y^3 + 3yz(y+z) + z^3 \\ px &= p(y+z) \end{aligned}$$

Or  $x^3 + px = y^3 + 3yz + p \times y + z + z^3 = q$

And if, in this last equation,  $3yz$  be taken  $= -p$ , we shall have the two following equations for determining the values of  $y$  and  $z$ : *viz.*

$$\begin{aligned} 3yz &= -p \\ y^3 + z^3 &= q \end{aligned}$$

Where, since in the first of them,  $z = -\frac{p}{3y}$ , if this value be substituted in the second, it will become

$$y^3 - \frac{p^3}{27y^3} = q$$

Or by multiplying by  $y^3$ , and then transposing the terms,

$$y^6 - qy^3 = (\frac{1}{3}p)^3$$

And as this equation is now in the form of a quadratic, on account of the index of the highest term being double that of the second, we shall have, by the rule already given for that purpose, and by simple equations.

$$\begin{aligned} y &= \sqrt[3]{\frac{1}{2}q \pm \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}} \\ z &= \frac{-\frac{1}{3}p}{\sqrt[3]{\frac{1}{2}q \pm \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}}} \end{aligned}$$

Whence  $x = y + z = \sqrt[3]{\frac{1}{2}q \pm \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}} - \frac{1}{\sqrt[3]{\frac{1}{2}q \pm \sqrt{(\frac{1}{2}q)^2 + (\frac{1}{3}p)^3}}}$

as was to be shewn.

As a practical application of the rule, let there be given the equation  $x^3 + 6x = 20$ , to find the value of  $x$ .

Thus, if  $p$  be put  $= 6$ , and  $q = 20$ , the analytical expression will become

$$\begin{aligned} \sqrt[3]{10 + \sqrt{100 + 8}} - \frac{2}{\sqrt[3]{10 + \sqrt{100 + 8}}} &= \sqrt[3]{10 + \sqrt{108}} \\ &= \sqrt[3]{10 + 10.3923} - \frac{2}{\sqrt[3]{10 + 10.3923}} \\ &= \sqrt[3]{20.3923} - \frac{2}{\sqrt[3]{20.3923}} \end{aligned}$$

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$= 2.732 - \frac{2}{2.732} = 2.732 - .732 = 2$ , which is the required value of  $x$ .

It happens, however, that the value of the unknown quantity is here only found by approximation; but this, when the root is a whole number, may always be avoided, for since in the present instance,  $\sqrt[3]{10 + \sqrt{108}} = 1 + \sqrt{3}$ , as may be proved by raising it to the third power, if this be substituted in its proper place, in the above expressions,

$$\begin{aligned} \text{we shall have } \sqrt[3]{10 + \sqrt{108}} - \frac{2}{\sqrt[3]{10 + \sqrt{108}}} &= 1 + \sqrt{3} \\ - \frac{2}{1 + \sqrt{3}} &= \frac{(1 + \sqrt{3})^3 - 2}{1 + \sqrt{3}} = \frac{1 + 2\sqrt{3} + 3 - 2}{1 + \sqrt{3}} \\ &= \frac{2 + 2\sqrt{3}}{1 + \sqrt{3}} = 2, \text{ as before.} \end{aligned}$$

Again, as a second example, let there be given  $x^3 - 6x = -q$ , to find the value of  $x$ .

Here  $p = -6$  and  $q = -q$

Then, by substituting these values in the above formula, we have

$$\begin{aligned} x &= \sqrt[3]{-4\frac{1}{4} + \sqrt{20\frac{1}{2} - 8}} - \frac{-2}{\sqrt[3]{-4\frac{1}{4} + \sqrt{20\frac{1}{2} - 8}}} \\ &= \sqrt[3]{-4\frac{1}{2} + 3\frac{1}{2}} + \frac{2}{\sqrt[3]{-4\frac{1}{2} + 3\frac{1}{2}}} = \sqrt[3]{-1} + \frac{2}{\sqrt[3]{-1}} \\ &= -1 + \frac{2}{-1} = -1 - 2 = -3, \text{ the required value of } x. \end{aligned}$$

But as a quadratic equation has been shewn to have two roots, or values, of the unknown quantity, so, in like manner, it may be proved that the unknown quantity, in a cubic equation, has three values or roots, each of which will be found to answer the conditions of the question.

Thus, in the first equation  $x^3 + 6x - 20 = 0$ , given above, where  $x$  has been found = 2, or  $x - 2 = 0$ , if  $x^3 + 6x - 20 = 0$  be divided by  $x - 2$ , we shall have  $x^2 + 2x + 10 = 0$ , or  $x^2 + 2x = -10$ , the roots of which equation, found according to the rule for quadratics, are  $-1 + 3\sqrt{-1}$ , and  $-1 - 3\sqrt{-1}$ , each of which, as well as the former root 2, are values of the unknown quantity, as will be found by substituting them for  $x$  in the given equation.

It must be observed, however, that neither the formula of Cardan, nor any other that has yet been discovered, will be found sufficient to determine the numerical value of the unknown quantity in every cubic equation that can be proposed; for when the coefficient of the second term of the equation is negative, and the cube of  $\frac{1}{3}$  of it is greater than the square of half the absolute term, the expression for the root becomes imaginary; and therefore no intelligible result can be derived from it.

Thus, if the equation proposed, were  $x^3 - 3x = 1$ , the analytical expression, when converted into numbers, will become  $x = \sqrt[3]{\frac{1}{2} + \sqrt{\frac{1}{4} - 1}} - \frac{1}{\sqrt[3]{\frac{1}{2} + \sqrt{\frac{1}{4} - 1}}}$

$\sqrt[3]{\frac{1}{2} + \frac{1}{2}\sqrt{-3}} - \frac{1}{\sqrt[3]{\frac{1}{2} - \frac{1}{2}\sqrt{-3}}}$ , the value of which cannot be determined either in integers, fractions, or rational surds; although, by substituting it for  $x$  in the given equation, the terms will all vanish as they ought; and consequently, in a certain sense, it may be said to be a root of the equation.

This defective state of Cardan's formula, or that in which it fails as a general rule, has commonly been called

the *irreducible case of cubic equations*; and notwithstanding the reiterated efforts of the most celebrated analysts in Europe, from the time when the want of generality in the rule was first observed, to the present day, no remedy has been found for this defect, except by a method of solution which is derived from the trisection of an angle, or by converting the expression into an infinite series; in which latter case that part of the quantity which is imaginary disappears, and by that means enables us to compute the root to any degree of exactness. For it is to be remarked, that although the unknown quantity cannot be determined from the formula itself, yet all the three roots are, in this case, real, and can be found, at least approximately, by either of the two methods last-mentioned.

Leaving this part of the subject, for the present, we shall next proceed to *biquadratic equations*, or those of the fourth power; any one of which, when the second term is taken away, may be represented, in general terms, by  $x^4 + ax^2 + bx + c = 0$ ; and the rule for the resolution of any equation of this form, is as follows:

Find the value of  $y$  in the cubic equation  $y^3 - \frac{a^2 + 12c}{3}y = b^2 + \frac{2a}{27}(a^2 - 36c)$ , by the rule before given for this purpose; and let the root, thus determined, be denoted by  $v$ .

Then find each of the values of  $x$  in the two following quadratic equations,

$$\begin{aligned} x^2 + (\sqrt{v - \frac{2}{3}a})x &= -\left[\frac{1}{2}a + \frac{1}{2}(v - \frac{2}{3}a)\right] + \frac{b}{2\sqrt{v - \frac{2}{3}a}} \\ x^2 - (\sqrt{v - \frac{2}{3}a})x &= -\left[\frac{1}{2}a + \frac{1}{2}(v - \frac{2}{3}a)\right] - \frac{b}{2\sqrt{v - \frac{2}{3}a}} \end{aligned}$$

And the values of  $x$ , thus found, will be the four roots of the biquadratic equation  $x^4 + ax^2 + bx + c = 0$ , as was required.

The rule, which is here given in a more commodious form than that of Des Cartes, may be readily demonstrated, by making the given equation  $x^4 + ax^2 + bx + c = 0$ , equal to the product of two quadratic equations, and then equating the coefficients of the homologous terms. Thus, if  $x^2 + px + q$  be multiplied by  $x^2 - px + r$ , and the product thence arising put = 0, we shall have  $x^4 + (r + q - p^2)x^2 + p(r - q)x + rq = 0$ .

Hence  $r + q - p^2 = a$ ,  $p(r - q) = b$ , and  $rq = c$ ; and consequently  $2r = a + p^2 + \frac{b}{p}$ , and  $2q = a + p^2 - \frac{b}{p}$ .

And if these values be substituted in the equation  $rq = c$ , or its equal  $4rq = 4c$ , we shall obtain, after proper reduction, the equation  $p^6 + 2ap^3 + (a^2 - 4c)p^2 = b^2$ .

Or, by putting  $p^2 = y - \frac{2}{3}a$ , and substituting it in the latter equation, we shall have for the result the cubic equation  $y^3 - \frac{a^2 + 12c}{3}y = b^2 + \frac{2a}{27}(a^2 - 36c)$ , which is that given in the rule.

Hence, if the value, or root of  $y$ , in this equation, be put =  $v$ , we shall have, from the equations given above,  $p = \sqrt{v - \frac{2}{3}a}$ ,  $q = \frac{1}{2}a + \frac{1}{2}(v - \frac{2}{3}a) - \frac{b}{2\sqrt{v - \frac{2}{3}a}}$ , and  $r = \frac{1}{2}a + \frac{1}{2}(v - \frac{2}{3}a) + \frac{b}{2\sqrt{v - \frac{2}{3}a}}$ . And by substituting

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Substituting these values in the two quadratic equations  $x^2 + px + q = 0$ , and  $x^2 - px + r = 0$ , they will become  $x^2 + (\sqrt{v - \frac{2}{3}a})x = -\frac{1}{2}a - \frac{1}{2}(v - \frac{2}{3}a)$

$$+ \frac{b}{2\sqrt{v - \frac{2}{3}a}}, \text{ and } x^2 - (\sqrt{v - \frac{2}{3}a})x = -\frac{1}{2}a - \frac{1}{2}(v - \frac{2}{3}a) - \frac{b}{2\sqrt{v - \frac{2}{3}a}}$$

the roots of which equations will be the 4 roots of the proposed biquadratic equation  $x^4 + ax^2 + bx + c = 0$ . As a practical example for the exercise of this rule, let there be given  $x^4 - 6x^2 - 16x + 21 = 0$ , to find the 4 values of  $x$ .

Then, if the numbers  $-6$ ,  $-16$ , and  $21$  be substituted in the place of  $a$ ,  $b$ ,  $c$ , in the cubic equation  $y^3 - \frac{a^2 + 12c}{3}y = b^2 + \frac{2a}{27}(a^2 - 36c)$ , it will become  $y^3 - \frac{36 + 252}{3}y = 256 - \frac{12}{27}(36 - 756)$ , or  $y^3 - 96y = 576$ , where the value of  $y$ , as determined by the preceding rule for cubic equations, will be found  $= 12$ .

Hence, if  $12$  be put for  $v$ ,  $-6$  for  $a$ , and  $-16$  for  $b$ , in the two quadratic equations,

$$x^2 + (\sqrt{v - \frac{2}{3}a})x = -\frac{1}{2}a - \frac{1}{2}(v - \frac{2}{3}a) + \frac{b}{2\sqrt{v - \frac{2}{3}a}}$$

$$x^2 - (\sqrt{v - \frac{2}{3}a})x = -\frac{1}{2}a - \frac{1}{2}(v - \frac{2}{3}a) - \frac{b}{2\sqrt{v - \frac{2}{3}a}}$$

they will become,

$$x^2 + (\sqrt{12 + 4})x = 3 - 8 - 2 = -7$$

$$x^2 - (\sqrt{12 + 4})x = 3 - 8 + 2 = -3$$

Or,

$$x^2 + 4x + 7 = 0$$

$$x^2 - 4x + 3 = 0$$

In the first of which  $x = -2 + \sqrt{-3}$ , or,  $-2 - \sqrt{-3}$ . And in the second,  $x = 3$  or  $1$ , which are the roots of the given equation  $x^4 - 6x^2 - 16x + 21 = 0$ ; there being always as many values of the unknown quantity, in any equation, as there are units in the index of its highest power; as will be shewn in a succeeding part of this article.

But before we proceed to any enquiries of this kind it will be proper to observe, that no general rule has hitherto been found for resolving equations of the 5th, 6th, or other higher orders, notwithstanding the numerous attempts that have been made for this purpose; so that in this respect we have not been able to advance a single step beyond what had been done by Louis Ferrari, Bombelli, and others in the early part of the 17th century, who were all acquainted with the method of resolving biquadratic equations; which is still the boundary that the most skilful analysts, assisted by all the advantages of a more comprehensive and commodious calculus, have not been able to pass.

But although no general resolution has hitherto been given of equations higher than those of the 4th power, there are, notwithstanding, some particular equations, of all orders, which, on account of certain relations subsisting between the coefficients of their different terms, may be resolved by the rules which have been given for those of the first four orders.

This is particularly the case with what have been usually called *reciprocal equations*, which are such that the coefficients of the terms form the same numerical series, whether taken in a direct or an inverted order; or that remain the

same when the reciprocal of the unknown quantity, or  $\frac{1}{x}$  is substituted for  $x$ .

Thus, for example, the equations  $x^5 + px^4 + qx^3 + qx^2 + px + 1 = 0$ ,  $x^4 + px^3 + qx^2 + px + 1 = 0$ , &c. which are of this kind, may always be transformed into others of a degree denoted by half the exponent of the highest power of the unknown quantity, if it be an even number, or by half the exponent diminished by 1, if it be an odd number.

Thus, let the last of the two equations given above,  $x^4 + px^3 + qx^2 + px + 1 = 0$ , be taken in the form  $x^2 + \frac{1}{x^2} + p(x + \frac{1}{x}) + q = 0$ , to which it can be readily reduced; then if  $x + \frac{1}{x}$  be put  $= z$ , we shall have  $x^2 + z + \frac{1}{x^2} = z^2$ , or  $x^2 + \frac{1}{x^2} = z^2 - z$ ; and if this be substituted

in the original equation  $x^4 + px^3 + qx^2 + px + 1 = 0$ , it will become  $z^2 + pz = z - q$ . And since  $x + \frac{1}{x} = z$ ,

we shall have  $x^2 - zx + 1 = 0$ . Hence, if the two roots of the equation  $z^2 + pz = z - q$ , be denoted by  $r$  and  $r'$ , we shall have the two following equations  $x^2 - rx + 1 = 0$ , and  $x^2 - r'x + 1 = 0$ ; the roots of which will be the four roots of the given biquadratic equation  $x^4 + px^3 + qx^2 + px + 1 = 0$ .

And in a similar way may any other equation of this kind be resolved, when the index of the greatest power of the unknown quantity is an even number.

And if the index of the unknown quantity be an odd number, as in the equation  $x^5 + px^4 + qx^3 + qx^2 + px + 1 = 0$ , it is obvious from inspection only, that  $-1$  is a root of the equation; and, consequently, if  $x^5 + px^4 + qx^3 + qx^2 + px + 1 = 0$ , be divided by  $x + 1$ , it will be reduced to the form  $x^4 + (p-1)x^3 - (p-q-1)x^2 + (p-1)x + 1 = 0$ , which is another reciprocal equation, a degree lower than the former; and having the index of its highest power an even number, it is consequently resolvable in the manner above explained.

Also, when two or more roots of any equation are equal to each other, the equation may always be reduced to another of an inferior degree, and the roots, by that means, determined.

Thus, if the cubic equation  $x^3 - px^2 + qx - r = 0$ , has two equal roots, each of them will be  $x = \frac{pq - qr}{p^2 - 6q}$ .

For, let the three roots be denoted by  $a, a$  and  $b$ ; then by the composition of equations we shall have  $x^3 - (2a + b)x^2 + (a^2 + 2ab)x - a^2b = 0$ ; where  $2a + b = p$ ,  $a^2 + 2ab = q$ , and  $a^2b = r$ ; and if these values be substituted in the above form, it will become  $x = \frac{pq - qr}{p^2 - 6q} = \frac{2a^3 + 4a^2b + a^2b + 2ab^2 - 9a^2b}{8a^3 + 8ab + 2b^2 - 6a^2 - 12ab} = \frac{2a^3 - 4a^2b + 2ab^2}{2a^2 - 4ab + 2b^2} = a$ , as was to be shewn.

Thus, let the equation  $x^3 + 5x^2 - 32x + 36 = 0$ , which has two equal roots, be the one proposed to be resolved.

Then since  $p = -5$ ,  $q = -32$ , and  $r = -36$ , if these values be substituted in the formula  $x = \frac{pq - qr}{p^2 - 6q}$ , it will become  $x = \frac{-5 \times -32 - 9 \times -36}{2 \times 25 - 6 \times -32} = \frac{160 + 324}{50 + 192} = \frac{484}{242} = 2$ , which is one of the equal roots of the equation.



# EQUATION.

sum of the products of all the roots, multiplied together, two by two.

3. The coefficient of the fourth term, taken with a contrary sign, is equal to the sum of the products, of all the roots, multiplied together, three by three; and so on to the last term, which is equal to the product of all the roots with contrary signs.

From this it also follows, that in an equation wanting its second term, there must be both positive and negative roots, and that the sum of the former is equal to that of the latter.

And in the same way, a number of other properties of the various orders of equations may be derived, which will be found of great use, not only with respect to their resolution, but as furnishing the materials for a complete investigation of this curious and interesting branch of analysis.

We shall only farther add, that besides the simple factors into which any equation may be decomposed, it may likewise be produced by multiplying together factors of any degree, provided the sum of their dimensions be equal to that of the proposed equation.

For the application of the principles and rules, illustrated in the preceding article, to the solution of arithmetical, geometrical, and other questions and problems, we refer to *REDUCTION of Equations, APPLICATION of Algebra, &c.*

**EQUATION**, in *Astronomy*, is a term used to express the correction, or quantity, to be added to or subtracted from the mean position of a heavenly body, to obtain the true; it also, in a more general sense, implies the correction arising from any erroneous supposition whatever. *E.g.* The time of noon, determined by taking equal altitudes of the sun, is first obtained by supposing the sun's declination constant during the whole interval, which false supposition is corrected by an appropriate equation. Most of the principal equations will be found under their different articles, in the various tables to which they belong.

**EQUATIONS, Construction of.** See **CONSTRUCTION of Equations.**

**EQUATIONS, Conversion of.** See **CONVERSION of Equations.**

**EQUATIONS, Absolute, adjoined or affected, differential, eminential, exponential, fluxional, literal, numeral, and transcendental.** See the adjectives.

**EQUATION of a Curve**, is an equation shewing the nature of a curve, by expressing the relation between any absciss and its corresponding ordinate, or else the relation of their fluxions, &c. Thus, the equation for the circle is  $ax - x^2 = y^2$ , where  $a$  is its diameter,  $x$  any absciss or part of that diameter, and  $y$  the ordinate at that part of the diameter; and the equation denotes, that whatever be the absciss expressed by  $x$ , the square of its corresponding ordinate will be  $ax - x^2$ . Thus also the equation for the ellipse is  $\frac{p}{a} \times ax - x^2 = y^2$ ; for the hyperbola  $\frac{p}{a} \times ax + x^2 = y^2$ ; and for the parabola  $px = y^2$ ; in all which  $a$  is an axis, and  $p$  the parameter. This method of expressing the nature of curves by algebraical equations was first introduced by Des Cartes, who, by thus connecting together the two sciences of algebra and geometry, made them naturally subservient and auxiliary to each other, and thus laid the foundation of the most considerable improvements that have been made in every branch of them since that time. See **APPLICATION of Algebra, &c.** See also **CURVE.**

**EQUATION of Payments**, in *Arithmetic*, is the method of reducing several debts payable at different times, and bearing

no interest till after the term of payment of a single debt or payment, to be discharged at once, without loss either to debtor or creditor, allowing simple interest; or, it is the method of finding the equated term at which these several debts should be paid in one sum. Cocker, Hatton, Kersey, fir Samuel Moreland, and Ward, have given rules for this purpose, which Mr. Malcolm has examined and found to be erroneous; and though the error resulting from any of the rules which they have proposed is not very considerable, the following process furnishes one more accurate.

Let the debt first payable be  $d$  | The last payable debt  $D$   
 called  $d$   
 The distance of the term of payment  $t$  | The distance of the term  $T$   
 The distance of the equated time  $x$

The rate of interest, or 1 year's interest of 1*l.*  $r$   
 The distance of the time  $t$  and  $x$  is  $x-t$  } for  $x$  lies between them.  
 The distance of the time  $T$  and  $x$  is  $T-x$  }

Then the interest of  $d$  for the time  $x-t$  is  $dr \times x-t$ , or  $drx - drt$ ,  $dr$  being one year's interest of  $d$ ; and  $\frac{DT r - Dr x}{1 + T r - r x}$  is the discount of  $D$  for the time  $T-x$ ,

because  $T r - r x$  is the interest of 1*l.* for that time, which is consequently the discount of  $1 + T r - r x$  for the same time; consequently, from the nature of the question, we shall have  $drx - drt = \frac{DT r - Dr x}{1 + T r - r x}$ ; which

being reduced, gives  $T + t + \frac{D + d}{dr} \times x - x^2 =$

$\frac{DT + dt}{dr} + Tt$ . Then make  $T + t + \frac{D + d}{dr} = a$ , and

$\frac{DT + dt}{dr} + Tt = s$ , and  $ax - x^2 = s$ ; and resolving this

quadratic equation,  $x = \frac{a}{2} \pm \sqrt{\frac{a^2}{4} - s}$ .

*E.g.* Suppose 100*l.* payable one year hence, and 105*l.* payable three years hence; what is the equated time, allowing simple interest at 5 per cent. per annum?

Here  $d = 100$  {  $D = 105$  }  
 $t = 1$  {  $T = 3$  }  $r = .05$ .

Then  $D + d = 205$ ,  $dr = 5$ , and  $\frac{D + d}{dr} = \frac{205}{5} = 41$ .

And  $T + t + \frac{D + d}{dr}$ , or  $a = 4 + 41 = 45$ .

And  $s$  or  $\frac{DT + dt}{dr} + Tt = \frac{315 + 100}{5} + 3 = 83 + 3 = 86$ . Consequently,

$x = \frac{45}{2} \pm \sqrt{\frac{2025}{4} - 86} = \frac{45}{2} \pm \sqrt{506.25 - 86} = 22.5$

$\pm \sqrt{420.25} = 22.5 \pm 20.5 = 43$  or  $2$ : but  $43$  cannot be the true answer by the conditions of the question, since it is greater than the distance of the last term in the question; and therefore  $2$  is the answer required.

If there are more debts than two you must first find an equated time for the two that are first payable; then consider their sum as a debt payable at that equated time, and find another equated time for that debt and the next of the given debts, &c. See Malcolm's *Arithm.* book vi. § 5, or p. 616-621.

**EQUATION of the Centre.** This is the first and most considerable of all the equations that are applied to the mean motion of a planet. It arises immediately from the nature of the ellipse. If the orbit of a planet was perfectly circular

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circular it would have no equation of the centre; and a spherical body, revolving round a centre of force in an elliptic orbit, undisturbed by the motion of other bodies, would require no other equation to correct its mean motion than the equation of the centre.

The necessity of applying this equation to the motion of the sun, in its apparent orbit, was known to the early astronomers; for, in fact, no very accurate observations were necessary to shew that the sun did not perform equal parts of its annual motion in equal portions of time. When, by means of gnomons, the length of the year and the obliquity of the ecliptic were pretty well established, it must have been easy, with the same instrument, to have observed the declination of the sun every day, and from thence to have computed its longitude. The first astronomers who undertook this examination must naturally have expected to find a regular increase in the sun's longitude for every day in the year; but when they found that in the course of three months the observed longitude differed near two degrees from that which they had computed, it became then evident, that if the sun's orbit was circular, and its motion uniform, at least the earth was not placed in the centre of it.

This difference, which we now call the equation of the centre, was named by the ancient astronomers *προσφαιρισις*, from *προσθεσις*, addition, and *αφαιρισις*, subtraction, because this equation is sometimes additive and sometimes subtractive, a name almost applicable to all equations, but applied to the equation of the orbit as the most considerable of all. Hipparchus was acquainted with this inequality in the motion of the sun, which had not long been discovered before his time. He observed, that from the equinox of spring to the summer solstice, there was an interval of  $94\frac{1}{2}$  days, and from the solstice to the next equinox  $92\frac{1}{2}$  days; that is, two days less, notwithstanding these points were equally  $90^\circ$  from each other. The motion of the sun in two days is  $1^\circ 58'$ , which is nearly the quantity of the greatest equation. To explain this difference, and to assign the exact proportion to every day in the year, the ancient astronomers either placed the earth out of the centre, at a sufficient distance to produce the greatest equation, or imagined an epicycle to revolve upon the circular orbit, on whose circumference the sun was supposed to move. These suppositions would give the sun's longitude near enough the truth to satisfy the imperfect observations of those days, and when similar inequalities were observed in the moon and planets, new cycles and epicycles were invented to explain them. But these contrivances, however ingenious, had very little pretension to be classed as theories or hypotheses, capable of giving a satisfactory explanation of the causes of these phenomena. An ingenious mechanic may make a clock, that shall represent all the inequalities of solar time, and by a proper application of some very simple principles in practical mechanics, we may represent the most complicated system of motions; yet these machines would give us no instructions as to the original motions which they imitated; and in proportion as they became complicated, should we be the less inclined to suppose any resemblance between their mechanism, and that of the motions they represented.

Nevertheless, in the simple case that we are now considering, had observation accurately agreed with the supposition, there would have been no reason for not admitting it; it would have rested on the same ground as Kepler's elliptic hypothesis, before Newton had demonstrated how obviously it is derived from one general law of nature.

• For the method of calculating the greatest equation of

excentric orbits, we refer the reader to De la Lande's *Astronomy*, vol. ii.

We shall here only explain the nature of this equation in an orbit perfectly elliptical. The equation of the orbit of a planet is evidently nothing at the apsidal; beginning to reckon from the aphelion it augments rapidly; as the true or real motion being there the slowest, differs most from the mean motion, it continues to increase, but less and less rapidly, till the planet has arrived at some point about three signs, and something more from the aphelion, at which point the true and mean motions are equal. At this time the equation is the greatest, it begins then slowly to diminish, and the diminution becomes more and more rapid, as it approaches the perihelion, at which time the real motion exceeds the mean motion by the greatest quantity. When it arrives at the aphelion the equation is again nothing. In the same manner it increases again to a maximum, and then diminishes till its return to the aphelion, where it is again nothing. The equation is subtractive in the first six signs from the mean motion, and additive in the others.

The greatest equation may be derived directly from observation; or if the excentricity be known it may be computed, and at the same time the degree of anomaly in which it happens. For this purpose it is sufficient to find the point M (*Plate XII. Astronomy, fig. 107.*) where the planet is at its mean distance. For it is evident, that the moment the planet arrives at the point where its angular velocity D F M is equal to its mean velocity, the mean longitude will cease to gain upon the true longitude, but their difference will be a maximum; because till that moment the real velocity, which was least, had continually caused the mean velocity to accelerate upon the true, but from the moment they are equal, the real velocity begins to accelerate upon the mean, and to regain the quantity which it had before lost: from this time the true and mean place approach each other, and the equation begins to diminish. Thus the problem consists in finding the point M, and the true anomaly A F M of the planet, at the moment that its true velocity is equal to the mean angular velocity.

Take FM a mean proportional between the two semi-axes of the orbit. With the focus F as a centre, and distance FM, describe a circle MN, which circle will have a surface equal to the ellipse. Suppose a body to describe uniformly this circle in the same time in which the planet describes its ellipse, its angular velocity will always be equal to the mean angular velocity of the planet in the ellipse; and the area described in the circle will be always equal to the area described in the ellipse, because the planet always describes equal areas in equal times. For example, if the planet describes in one day an area D F R =  $\frac{1}{353}$ th part of the elliptic surface, the area E F O, described in the circle, will likewise be the  $\frac{1}{353}$ th part of the area of the circle; and the real velocity of the planet, or the angle D F R, will be equal to the mean velocity in M, that is, to the angle E F O; for there are two equal sectors having the same length E M, the same surface, and consequently the same angle. Besides the equal triangles M E D, M R O, which are the one without, and the other within the circle, shew that the elliptic sector is precisely equal to the circular sector, that has the same angle in F. Therefore to find the point of the mean velocity, we must find at what degree the intersection of the ellipse corresponds with the circle equal to it in surface. From the point M let the straight line M B be drawn to the other focus of the ellipse, then in the triangle B E M three sides will be known; namely, B F, which is the double of the excentricity, F M, which is the mean proportional between the two semi-axes, and B M, which is the difference between

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FM, and the greater axis, because the two lines EM and MB are together equal to the greater axis. By resolving this triangle the angle F may be found, which will be the true anomaly of the planet, at the time of its greatest equation.

In the case of the greatest equation, the resolution of the above triangle gives the following rule. From the aphelion distance take separately the mean proportional of the two semi-axes, and the third side BM (difference between the greater axis and the mean). Take the logarithms of these differences, and subtract the least from the greatest; from this difference take the difference of the logarithms of the aphelion and perihelion distances; the half of the remainder is the logarithmic tangent of half the true anomaly. By the method of cosines take the logarithms of the aphelion distance, and of the difference of the side BM; add the complements of the logarithms of BE and FM, the half of the sum is the logarithmic cosine of half the true anomaly. If the angle is small, this method of the cosines is less exact; but when the angle is large, it is preferable to the other, being somewhat shorter.

Having thus described the method of calculating the greatest equation, we have now to consider the manner of observing it.

From the instant a planet departs from its aphelion A, to the time it arrives at the point M of its greatest equation, its real velocity is less than its mean velocity; therefore, the true anomaly is less than the mean anomaly, and differs from it more and more. When the planet has passed the point P, or its perihelion, and arrives at the point G, having about nine signs of anomaly, its true distance AFG from the aphelion is in the same manner less than its mean distance, by a quantity equal to the greatest equation. If we observe two true longitudes of the planet in G and M, they will differ from each other by the angle GFM, which is the sum of two true anomalies: but the sum of two mean anomalies will be greater by the double of the equation, since each true distance is less than the mean distance by the whole of the equation. It is easy to calculate the sum of two mean anomalies without knowing the place of the aphelion A, because the sum of two mean anomalies is equal to the mean motion of the planet for this interval of time, which is found by taking its proportion of the whole revolution: thus, the excess of the mean motion, calculated over the true distance observed, will be double the greatest equation, provided the two observations are made in M and G, the times that the mean velocities equal the true. It will, on the contrary, be the true or observed motion that will exceed the mean, if the observations are taken on each side the perihelion. To determine the time and the observations most suitable to this investigation, an observer, who should be supposed to have no previous knowledge of the situation of the orbit, must begin by collecting a great number of observed positions, and compare them two and two together, and observe how much the observed motion differs from the mean for each interval: in this manner the greatest of the observed distances will be found double the greatest equation; but if this comparison is made with a single observation, then the greatest difference additive and the greatest subtractive, added together, will give double the equation. But since at present we know very nearly the place of the apsidæ, and of the mean distances of all the planets, we can immediately select the observations that are made about the time of the greatest equation.

*Example.*—The 7th October, 1751, the place of the

sun observed by La Caille, was, after three successive observations

6	13°	47'	13".7
0	8	9	25.5

5	24	22	11.8
5	20	31	43.2

0	3	50	28.6
0	1	55	14.3

This would be exactly the greatest equation, if the observations had been made exactly at the moment of the greatest equation; but having calculated by the tables these equations, it was found that 18".6 must be added to have the greatest equation, which will make the above quantity 1° 55' 33".

With respect to this 18".6 it may be remarked, that an error of several minutes in the equation of the tables would have produced no sensible alteration in this correction, as the error would be the same for the given day as for the greatest of all which happened extremely near it.

As it is extremely rare to meet with two observations which are precisely situated in the two points M and G of the mean time, so it is not easy to find by the first calculation the exact value of the equation; but after having found it very nearly, and likewise the place of the apside, the equation may be calculated for the times of observation, and likewise the greatest equation; by the method explained above, it may be then seen how much the equation derived from the observations should differ from the greatest. It was by this means that La Caille, in the preceding example, found the above correction 18".6. The greatest equation of the sun is that which may be observed the most frequently, and with the greatest ease. A person studying astronomy, and desirous of making himself conversant with the methods by which all these elements of the planetary motions have been obtained, may deduce them himself from the Nautical Almanac, or other similar publications; he may regard the longitudes and latitudes of the planets there found as so many observations, and by computing from them, the original elements should be found, from which the tables themselves were calculated. If the minutes and seconds be omitted, or the nearest half or quarter of a degree only taken, they will represent the observations of the early astronomers, and it will then be seen what very imperfect theories were sufficient to explain such inaccurate observations.

These methods of finding the greatest equation cannot be applied to Mercury, as we never can observe its heliocentric longitude but when on the sun's disc. Its elongation, and that of Venus, is found by observing the greatest digression when the planet is in the apsidæ. For a farther account of this method consult De la Lande's Astronomy.

Cassini employed the transits of Mercury observed in 1661, 1690, and 1697, and found the greatest equation 24' 3". De la Lande, from the transits of 1740, 1743, and 1753, found 23° 27' 51". But these observations are not well suited, as the three points of the orbit are not disposed at distances sufficiently great. The equation of the centre does not remain for ever the same; by comparison with ancient observations the equation of the earth's orbit appears to have undergone a diminution, and the theory of attraction explains the cause, and assigned the quantity more correctly than can be obtained by observation. La Place makes the diminution for the earth's orbit 0°.0058 decimals in a century;

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lary; this phenomenon supposes a corresponding diminution in the excentricity, for if the excentricity was nothing, the equation would be nothing. The corresponding diminution of the excentricity is 0.000045553, the semi-axis major being taken as unity.

This is nearly equal to 1548 French leagues in a century, or 40 English miles in a year. Thus, fractions which appear insensible in the heavens, become considerable when compared with our known measures. If this diminution was always progressive, the solar ellipse would in time be changed into the circumference of a circle, and in the end, the ex-

centricity decreasing always, the earth, after a great number of ages, would fall into the sun; but the theory of attraction indicates that the variation in the equation of the orbit and excentricity are periodic, and that after having diminished for a certain period, they will again increase and take the same values they had before, and will thus oscillate within narrow limits; but the periods of these oscillations are still unknown, and thus the system might be eternally maintained, except some exterior and unknown cause shall come to change the system of the world, and new-modify its laws.

TABLE of the greatest Equation of the Centre according to different Astronomers.

	Bouillaud, 1645.	La Hire, 1702.	Halley, 1719.	Cassini, 1740.	La Lande, 1750.	Annual Variation.
Mercury - - -	24° 17' 20"	24° 16' 52"	23° 42' 36"	24° 2' 58"	23° 40' 0"	+ 0".02
Venus - - -	0 54 36	0 50 0	0 48 0	0 49 6	0 47 20	- 0.25
The Sun - - -	2 2 41	1 55 42	1 56 20	1 55 51	1 55 36.5	- 0.188
Mars - - -	10 36 12	10 40 40	10 40 2	10 39 19	10 40 40	+ 0.37
Jupiter - - -	5 34 0	5 36 54	5 31 36	5 31 17	5 30 38.3	+ 0.5536
Saturn - - -	6 37 10	6 30 00	6 32 4	6 31 40	6 26 42	- 1.11
Herschel - - -					5 27 16	- 0.11

*EQUATION, Secular, of the Mean Motion of the Moon.* The motion of the moon, and its elements, do not remain constant, but undergo progressive alterations, which would soon render the tables inaccurate, if we were obliged to improve merely by comparison with recent observations. The only method of avoiding this inconvenience is to calculate the elements of the lunar motion for different periods very remote from each other, to deduce the variations they have undergone, and then to investigate the laws proper to represent them.

We may apply these considerations to the mean and secular motion of the moon, which has been determined with great exactness by modern observations, and which serves as a basis for all the other results, and compare it with ancient observations, to see if it is the same, or if it has materially changed. The method of making this comparison consists in considering the ancient observations of the moon as so many observed longitudes; the place of the moon is then calculated by the tables for this distant epoch, and the result compared with the observation.

The most ancient eclipse upon record may be taken as an example. It was observed by the Chaldeans 721 years before the Christian era, and recorded by Ptolemy. The observation was made at Babylon the 19th March: the moon began to be eclipsed about an hour after its rising. At the middle of the eclipse the longitude of the moon was equal to that of the sun; this latter is easy to calculate by the solar tables; thus the longitude of the moon is given at the period of the eclipse. Now, if the place of the moon be calculated by the tables for this epoch, it will be found less advanced in its orbit, than it must have been by the observation: the difference is about one degree and a half; and as this is too great an error to be attributed to the inaccuracy of the tables, we must conclude that the motion of the moon is now accelerated: so that in referring it to a distant period, we throw it too far back in its orbit, which diminishes its longitude.

And this result acquires additional confirmation, by making similar comparisons with observations made at in-

termediate periods; for if the motion of the moon is really accelerated, we should still find the longitude calculated by the tables too small, though the error should be less as the interval is smaller; and this appears to be the case by a similar comparison with an eclipse observed at Cairo by Ibn-junis, an Arabian astronomer of the 10th century.

This coincidence leaves no doubt as to the reality of the phenomenon; and it appears certain, that the motion of the moon has accelerated from the time of the Chaldeans to the Arabians, and from that time to the present. To represent this acceleration, a third term, proportional to the time, must be added to the secular motion of the moon, and another lesser term proportional to the cube; this, together, is what is called the secular equation of the moon. According to La Place, (*Mecanique celeste*, vol. iii. p. 273.) if  $n$  be the number of centuries elapsed since 1750, the formula for the correction will be  $31''.424757 n^2 + 0''.05721742 n^3$ . These seconds are according to the decimal division.

But we are not to infer that this acceleration will always be increasing, or that the preceding formula will always represent it; the theory of attraction, in making known the cause, has shewn that it is periodic, and connected with the variations of the excentricity of the terrestrial orbit. See *EXCENTRICITY, and EQUATION of the Centre.*

This acceleration, after increasing to a certain limit, will be changed into a retardation, but the extent of this period is very considerable; and the interval, which separates us from the most ancient observations, has yet only developed an extremely small part of this revolution. The inequalities which will result in the motion of the moon will amount at least to a 40th part of the circumference of her orbit. Posterity, who will observe these great phenomena, may remark, and not without gratitude, that the geometers of the present age have foreseen, calculated, and prepared for their successors the means of judging of the past and future state of the system of the world, with the same certainty as in the age in which they lived.

It was the celebrated Dr. Halley who first discovered the effects of this acceleration; and La Place, by a most profound

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found analysis, has explained both the cause and the law. The observer and the geometrician are each entitled to admiration. If the result of the latter is more satisfactory and useful to science, it must be confessed, that it was a proof of no small sagacity in the former to be the first to doubt of the uniformity of the mean motions which had been admitted as an established principle for above two thousand years.

**EQUATIONS, Secular, which affect the Elements of the Orbit of the Moon.** The motion of the lunar perigee is not uniform, but subject to a secular equation analogous to that of the mean motion, and depending on the same cause. The comparison of ancient observations with the modern leaves no doubt of this fact; but it is to the theory of attraction that we are indebted for the discovery. This equation is equal to that of the mean motion, multiplied by the coefficient  $-3.00052$ , that is to say, that if  $k$  represent the secular equation of the mean motion, the term  $-3.00052k$  must be added to the mean longitude of the perigee, calculated from the duration of a tropical revolution. *Mec. celeste*, vol. iii. p. 247.

The motion of the nodes is likewise subject to a similar inequality, and the equation has the same sign as that of the perigee, it is equal to the equation of the mean motion multiplied by  $-0.735452$ , that is, to the mean longitude of the node add  $-0.735452k$ . These results are confirmed by observation.

It appears from this, that the secular equation diminishes the longitude of the perigee and of the nodes when it augments the mean motion of the node, and reciprocally; hence the motion of the perigee and of the nodes becomes slower, when that of the moon is accelerated, and on the contrary is accelerated when that of the moon is retarded. Moreover, these inequalities are connected together by very simple analogies, since they are represented by the numbers  $1$ ;  $3.00052$ ;  $-0.735452$ .

The anomalistic revolution, depending at the same time on the motion of the moon and of the perigee, is likewise modified by the secular variation. It is the same with all the quantities which depend on the apogee, and on the nodes.

The theory of attraction indicates, that the distance of the moon from the earth, the excentricity, and the inclination to the orbit, are equally subject to secular equations, which are connected with that of the mean motion. But hitherto their effect is scarcely perceptible; nevertheless, in the course of ages, it will become necessary to attend to them, and they have been calculated in advance. The expression for the greater axis of the orbit contains no inequality of this kind. This likewise is the result of theory. The cause of all these extremely curious facts has been explained by La Place, who was led to them by the discovery of the original cause which produced the secular equation of the moon. For the secular equations of the other celestial bodies, see their respective names, and **SECULAR**.

**EQUATION-Clock**, in *Horology*, is a clock contrived so as to indicate both *mean* and *equated* solar time, and consequently their difference, which at any instant is the *equation of time*. Various contrivances have been invented to answer this purpose by ingenious men, who at one time were seized with a rage for inventing such useless appendages of the clock, but the dictatorial power of fashion has nearly banished such superfluities, that are now considered as mere matters of curiosity. For a description of a clock of this sort by Enderlin, see our article **CLOCK**, and *Plate XXIV. of Horology*.

**EQUATION-Mechanism**, in a planetarium or orrery, is a mechanical contrivance for representing the alternate accelerations and retardations of motion in the requisite parts of the respective orbits of the different planets, which contrivance has been variously effected by different ingenious men. If

the motions of the heavenly bodies had been in concentric circles, and perfectly equable in every point of their orbits, the construction of a common planetarium would have been well calculated to exhibit all the phenomena in a natural and exact manner, provided the trains of wheelwork were accurately calculated for the respective periods, and the length of the arms proportional to the respective distances; but as all the planets that have considerable excentricity, and consequently considerable equations of the centre alternately *plus* and *minus*, have their motions constantly varying in angular velocity, a common planetarium, without equation-mechanism, is a very imperfect machine, and by no means competent to solve any of the phenomena, in a particular way, that depend on the relative velocities; for when the heliocentric motions are improperly represented, the geocentric appearances depending on them are deranged, and no dependance can be placed in the *times* pointed out of the apparent conjunctions, oppositions, stations, retrogradations, longitude, or latitude of any of the heavenly bodies. For instance Mercury, which planet performs its period through the ecliptic in somewhat less than 88 days, instead of continuing 44 days in each half of its orbit, at opposite sides of the conjugate axis, as it does respectively in those at each side of the transverse axis, continues about  $55\frac{1}{2}$  days in the aphelion portion, and only  $32\frac{1}{2}$  in the perihelion portion, so that the times of conjunction with the earth or other planet, even allowing the motion of that planet to be equable, would from this cause alone become very irregular, exceeding or falling short of the mean synodic period by many days, according to circumstances. It is evident, therefore, that the variations of velocity depending on the equation of the centre of both orbits of two planets, one received from the other, require to be taken into consideration, and allowed for in the construction of any mechanism that professes to be accurate in the representation of planetary motion.

*Contrivances by Mr. Huygens.*—The earliest attempt that we have met with, to produce the requisite inequalities of planetary motion by mechanism, is that of Mr. Huygens, the Dutch mathematician and philosopher, which he has described in his Latin treatise on the construction of his *Automaton*, or self-moving planetarium; he has availed himself of two different applications of the same principle, that are respectively applicable to different degrees of inequality of motion, that the excentricity of an orbit may require; his account and demonstration of both which methods we shall give in a free translation from his own words, which will probably be interesting to those who cannot read the original; particularly as there has been no notice taken of them by any writer, or instrument-maker, except perhaps Rowley, during the last century.

“It remains now,” says our very ingenious author, “that we explain how the true anomalies may be represented by wheelwork; for this purpose let ANP, *fig. 1. of Plate III. of Planetary Machines*, be the orbit of a planet, the centre of which is C with the sun at S, and let the point E be taken any where in the line SC, so that the excentricity SC may be to the radius CA, as CE is to ED; with which radius and centre E let the circle DM be described. Now let it be understood, that upon the centre of the circle AL there be fixed immoveably the contrate wheel DM with equal teeth, which therefore will necessarily revolve round the point C as a centre; let it be also supposed that the arbor of the long pinion KH be directed to C, and turned equally with its teeth adapted to those of the wheel DM, which will agree sufficiently, although on account of the excentricity of this wheel it will not always have the pinion at right angles; by this motion, I say, a planet will be

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be carried unequally in its orbit, and in such a manner that its motion will very nearly correspond to Kepler's hypothesis; For having taken in the circle  $DM$ , described from the point  $E$ , any arc  $DO$ , let the teeth of that arc pass over to the line  $CD$  by turning the pinion  $KH$ , and the line  $CO$  will coincide with the line  $CAD$ , but not so that the point  $O$  may fall on the point  $D$ , but within at  $R$ , because  $CD$ , which is equal to both  $CE$  and  $EO$ , is greater than  $CO$ : now whatever may be the angle  $OC D$ , such will be that over which the line  $CAD$  has moved round the centre  $C$ ; therefore if we make the angle  $DC T$  equal to the angle  $DC O$ ,  $CT$  will be the right line into which  $CAD$  will have advanced, so that the planet will have proceeded from  $A$  to the point  $N$ , where the right line  $CT$  cuts the circumference of the circle  $AN$  described from the centre  $C$ . But the circle  $DM$ , having its centre  $E$  advanced to  $F$  by making  $FT$  equal to  $ED$ , will have the same situation as the circle  $TR$ : and it appears that on account of the equality of the angles  $OC D$  and  $DC T$ , the arc  $DM$ , which the right line  $CT$  cuts in the circumference of  $ODM$ , is equal to the arc  $DO$ ; so that  $M$  and  $E$  being joined, the angle  $MED$  will be equal to  $DEO$ . If, therefore, the arc  $AL$  be made to contain as many degrees as the arc  $DM$ , and  $CF$  be joined, this line will be parallel to  $EM$ .

"In the triangles  $CEM$  and  $SEL$ , therefore, the angles  $LCS$  and  $MEC$  will be equal, and the subtending sides proportional; for by construction  $SC$  is to  $CL$ , as  $CE$  is to  $EM$ ,  $CL$  being equal to  $CA$ , and  $EM$  to  $ED$ . Also the angles  $MCE$  and  $LSC$  are equal, and consequently the lines  $CM$  and  $SL$  are parallel.

"Now by this rotation of the circles  $DM$  and  $AL$ , the planet placed in  $A$  will be moved through the circle  $AL$ , very nearly according to Kepler's hypothesis, as may be thus shewn. Let the planet be supposed to have moved from  $A$  to  $N$ , the space or area  $NSA$  will be equal to its mean anomaly; but seeing the lines  $SL$  and  $CN$  are parallel, the triangles  $NSC$  and  $CLN$  will be equal, at least their difference will be insensible; the space or area, therefore,  $CLA$ , and consequently the arc  $AL$ , will answer to the mean anomaly when the planet has advanced from  $A$  to  $N$ . If, however, we make  $AQP$  the elliptic orbit of Kepler, the planet will be in  $Q$ , where the perpendicular  $NQ$  falling on  $AP$  cuts the ellipse  $AQP$ , and not in  $N$ ; but the ellipses are so like circles, that the variation in a machine is imperceptible,  $N$  will, therefore, be the true place of the planet corresponding to the mean motion  $AL$ , which arc is equal to  $DO$  or  $DM$ .

"Again, if the pinion be placed in any other point, as at  $G$ , equally distant from the centre  $C$ , to which the arbor is directed, and the point  $D$ , which is the most distant from the centre  $C$ , in the wheel  $ODM$ , be placed under the pinion, the planet being again at its aphelion  $A$ , it appears that the same angles are formed round the centre  $C$  by an equable motion of the pinion placed in  $G$  as in  $D$ . Wherefore in whatever situation the pinion be placed, the motion of the planet will be unequal, notwithstanding the teeth of the wheel  $DM$  are made equal among themselves, provided the pinion that points to the centre  $C$  have its teeth made long enough to act with all the teeth of the wheel which come successively to it at different distances from the centre  $C$ , and provided that the planet be put to its aphelion point of its orbit, when the longest line, or radius, drawn from  $C$  to  $DM$ , is in contact with the pinion.

"But since in our machine (automaton) all the pinions are placed on one common arbor, it cannot be placed properly towards the centres of more than two planets; we must, therefore, consider how the same effect can be produced

by *unequal teeth*: for this end let us suppose the circle  $DM$  divided into the equal parts  $Da, ab, bM$ , and  $Mg$ , and right lines be drawn to them from the point  $C$ , these lines  $Ca, Cb, CM, Cg$ , will divide  $ANL$ , the orbit of the planet, into the unequal parts  $Ad, de, eN, Nf$ . By this method as many unequal teeth may be determined in the circle  $ANL$ , as there are equal ones in the circle  $DM$ . If now the pinion be applied to these teeth, cut into the same number as in the former case, they will work together pretty well, though some are too large and others too small for the pinion, and the wheel  $AN$  will move unequally as the wheel  $DM$  did before, which has been proved to be according to the hypothesis of Kepler."

This is a faithful translation of Mr. Huygens' account and demonstration of his two methods of representing the irregularities of a planet's motion in its orbit, concerning which we have to observe, that, though both of them manifest great ingenuity as to the originality of the projects, yet they fall short of producing separately that full effect which he attributes to them, and which he seems to have credited; whereas the truth is, that instead of effecting the whole equation of the centre, the methods just described effect each only *one half* thereof; for agreeably to Kepler's theory, which supposes equal areas in equal times, bishop Ward has proved that *double the eccentricity* of a planet's orbit subtends very nearly its greatest equation, and that, according to his elliptic hypothesis, which is an excellent approximation to the truth, if the angular velocity of a planet round one focus of the ellipse be uniformly equable, its angular velocity, as seen from the other focus, will be so unequal, that one will represent the mean and the other the true or equated anomaly very nearly; but the distance between the two foci of any ellipse is its eccentricity laid off both ways from the centre, or *doubled*; whereas the method of Mr. Huygens' proposes the eccentricity to be taken only *once*, so that he has demonstrated rightly enough, but from wrong data; for if he had made the distance  $CE$  equal to double the eccentricity, then the whole of the equation would have been very nearly represented. The demonstration which Mr. Olinthus Gregory of Woolwich, then of Cambridge, has given in the 2d vol. of Mr. Nicholson's Philosophical Journal of the 8vo. series, to which we beg leave to refer, has proved with great perspicuity what the Rev. W. Pearson of Parson's Green had before asserted, that "the eccentricity of any planet's orbit is very nearly equal to the sine of one half only of its greatest equation." It may be considered as a singular circumstance that a man of Mr. Huygens' genius and mathematical skill, whose whole life was devoted to the sciences, should not discover that the methods which he so ingeniously devised to exhibit a planet's equated motion, produced but one half of the grand equation; and equally singular, perhaps, may it be considered, that no one before the writer of this article has detected the deficiency. When both these methods of constructing a planetary wheel are *united*, the full effect will be produced; or either of them may be united with any other contrivance that produces only one half the equation.

*Mr. Roemer's Contrivance.*—The next contrivance that we have met with, for representing planetary motion, is that of Roemer, who was mathematician to the king of France in the time of Mr. Huygens; this contrivance is detailed in Mr. Nicholson's Journal, vol. 4. of the 4to. series, by a correspondent, who translated his account from the French of "Machines and Inventions approved by the Royal Academy of Sciences for 1699," and who, in our opinion, speaks better of it than it deserves. The plan proposed might answer for one planet only, but is not applicable to a number of planets at the same time, for the planetary wheel proposed

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is intended to be so thick as to constitute the frustum of a cone, on the surface of which a diagonal elliptical line is to be drawn round it, from the smaller to the larger diameter and back again, in which line the teeth are to be formed, after they have been laid down by a pair of dividers from a diagram previously made; so that, setting aside the tediousness of making such a wheel by the mechanical manipulation described; there could not be a number of these wheels brought into action by any of the usual arrangements of wheelwork, seeing the pinions that are to act with them must necessarily be conical also, and be the drivers in every case, which the requisite calculations of the trains in planetary machines will not always admit, where the extreme ratios of relative velocity are so widely different from each other. This plan, therefore, of exhibiting unequable motion in a planetarium, or orrery, must be considered among those projects of ingenuity which are more plausible in theory than serviceable in practice, and no doubt was abandoned for the reasons that have been here stated; which are our reasons for passing over it without further notice.

*Dr. Desaguliers' Contrivance.*—The next mechanism in the order of time, as far as we know, was Dr. Desaguliers' elliptic pulleys, or oval wheels with grooves at the circumference, and an endless cat-gut surrounding them, as described under our article COMETARIUM. This was certainly a scientific contrivance, and admits of application where the excentricity of the orbit is great; for the excentricity and shape of the pulleys may be made exactly similar to the excentricity and shape of the orbit to be represented. The principal objection to the adoption of this invention in a planetarium, is the liability of the cat-gut to contract and elongate with the variations of moisture in a room, and consequently to be sometimes too tight for the pulleys, and sometimes too loose, so as not to perform their office of giving motion to the elliptic plates. We have seen the elliptic plates with their edges cut into teeth, which is a great improvement in the contrivance; and where the excentricity is not very great, a pair of excentric circular wheels will act together very well, to answer the same purpose, as we shall have occasion to shew presently.

*Mr. Adam Walker's Contrivance.*—Another method of exhibiting planetary motion we have witnessed in the philosophical lectures of Mr. Walker, senior, which, if we recollect perfectly, was effected thus: A wooden board was shapen nearly into the form of an epicycloid, and had equal teeth cut on its circumference by hand, with an arm fixed fast to one of its extremities, that carried the stem of a planet, or of a ball to represent a planet; then a pinion was fixed on the surface of an inclined plane, down which the epicycloidal wheel was suffered to slide by its own weight, in a detached state, till its teeth came in action with the teeth of the pinion; and a motion given to the pinion by a handle, made the wheel, thus circumstanced, to revolve with unequal velocities, accordingly as its central point was near to, or removed from, the pinion, during its revolution in this sliding state; thus were not only the accelerations and retardations of motion alternately exhibited, but also the variations of distance, as they regarded the sun's ball fixed in the focus of an elliptical board, placed over this mechanism, and divided into twelve triangular areas, so that the planetary body was seen to move through the twelve sectors, coloured alternately white and black, in a manner corresponding to the same number of revolutions of the pinion; and to perform apparently equal areas in equal times. It is hardly necessary to observe on this contrivance, that, however convenient it might be to illustrate in a general way the nature of planetary motion to an

audience, it is obvious that detached wheels acting thus at liberty cannot be introduced into any machine that gives motion to a system of bodies, where their apses cross one another in various directions, and would require as many inclined planes as there are planets to be represented; likewise the planetary arms would require to be attached to wheels in every instance, though the calculations of the ratios of velocity might, and, according to the general constructions, would require in some instances pinions to be the last movers; all which difficulties in practice are insurmountable. The shape of the planetary wheel, we have understood, was not determined geometrically, nor yet by calculation, but by a repetition of manual rectifications of the figure till it was found to correspond with the areas previously delineated.

*Mr. Joseph Priestley's Contrivance.*—When Dr. Birbeck was appointed professor to succeed the late Dr. Garnet, at Anderson's University in Glasgow, his friend, Mr. Joseph Priestley of Bradford, contrived an orrery, which was made for him by a watch-maker at Halifax, of the name of Thomas Lister, which orrery the doctor has lately brought with him to London, on quitting the said professorship. It was finished in the year 1801, and will be described in its proper place with the other planetary machines. The inequalities of motion in this machine are produced by two separate methods; the two superior planets Saturn and Jupiter have their equations effected by inequalities made in the teeth of the last moving wheels; but the others have their equations, with the exception of the earth, produced by a contrivance which is at the same time novel, simple, and accurate enough for mechanical representation. The inventor has been kind enough to comply with our request of his giving us an account of his mode of producing unequable motion by mechanism, which account we shall present to our readers in his own words. The figure to which he refers, is *fig. 2. of Plate III. of Planetary Machines.*

Let  $A P B$ , says Mr. Priestley, be the orbit of the planet,  $O$  its centre, and  $S$  and  $F$  the two foci; in the former of which the sun is supposed to be placed. On the other focus  $F$ , as a centre, describe a circle  $D E p$ .

Let  $P$  be any given place of the planet in its orbit; draw  $F p$ , cutting the circle  $D E p$  in  $p$ . Now, agreeably to the hypothesis of Ward, it will be,

As the periodical time of the planet,  
Is to the time of its passing from  $A$  to  $P$ ;  
So is 360 degrees,  
To the angle  $E F p$ .

Hence, if a point  $p$  be made to revolve equably in the circle  $D E p$ , described on the lower focus  $F$  of the orbit, performing one revolution in the periodical time of the planet; and if, at any given time, the point be found at  $p$ , then a line drawn from the focus  $F$  through  $p$ , will cut the orbit of the planet in  $P$ , its place at the same time.

There are different ways of adopting this hypothesis in machinery. The first I shall mention, will immediately occur to any one viewing the figure. Let a wire, something longer than  $F B$ , be made to revolve equably round  $F$ , in the time representing one revolution of the planet. On this wire let a stud  $P$  be made to slide freely, and confined to move in the orbit  $A P B$ ; then the motion of the stud will, very nearly, represent that of the planet.

In the construction of an orrery, where each planet will require a separate arm  $F p$ , moveable on its peculiar centre, with the slider  $P$  confined to its own orbit, it may not be easy to contrive the whole so as to prevent one part of the machinery from interfering with another; nor can this method be conveniently used, where the wheels carrying the

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arms are rims. The following construction has been found to answer the intention, and the motion to be very free and regular.

Let  $E \rho D$  be the toothed rim moving equably, the time of a revolution representing that of the planet. This rim may have any convenient diameter, not differing greatly from the orbit. Upon this rim, or on any projection attached to it, is fixed a pin  $C$ , round which one end of a bar  $CP$  moves; on the other end of the bar is fixed a perpendicular wire, or stem  $P$ , which carries the planet. This stem is confined to move in the orbit  $APB$ ; and, during its revolution, is made to rise and fall, so as to shew the inclination of the orbit to the ecliptic. The bar  $CP$  may be made of any convenient length; and the pin  $C$  should be so situated, that when  $P$  is at  $\rho$ , the bar becomes a tangent to the circle  $E \rho B$ . This is necessary, that the end  $P$ , in its vibrations on  $C$ , may be always found, as nearly as possible, in the line  $F \rho$ ; and on this account, the length of the bar should be as great as circumstances will conveniently admit.

*Contrivances by the Rev. William Pearson.*—Some time previously to the year 1796, the Rev. William Pearson, who lived at that time in the city of Lincoln, had read the accounts of Mr. Benjamin Martin's and Mr. James Ferguson's planetary mechanism with such attention, as enabled him to discover many imperfections in them, which it appeared to him might be avoided, and among the rest that defect which arises from equable motion and unvarying distance. On entering into a correspondence with one of the instrument-makers in London, he found that the modern machines owed their origin chiefly to one or the other of the above-named authors, and that little or no improvement had been made in the accuracy of their representations since their time. In consequence of this information, and unacquainted with the contrivances we have just described, except that of Dr. Desaguliers, described by Mr. Ferguson, he turned his mind towards the subject with a view of devising some improvements in this kind of machinery, which required an union of mechanical skill, with a knowledge of the science of astronomy, to enable him to strike out original plans for the accomplishment of his purpose. His first object was to render the trains of wheel-work as nearly as possible such as would produce the true periods of the different planets in their orbits, in doing which he found no difficulty after he had adopted a direct and unerring system of calculation, which became easy and familiar by practice; but this part of his pursuit is not the object of our present article: the next object of his attention was to devise the mechanical means of exhibiting planetary motion, both with regard to variable velocity and variable distance; different methods presented themselves in succession at different times, some of which he afterwards found had been tried before by others, but the first project that promised to be really subservient to his purpose was that which was represented in *fig. 3. of Plate III. of Planetary Machines*, and which was made for the arm of Mercury, in an orrery constructed under his direction, by a clock-maker at Lincoln. The contrivance had three objects in view, the variable distances, the variable velocities, and the latitudes of the planets, or deviation from the ecliptic, two of which purposes it answered most completely, and the third in a certain degree, besides preserving, fourthly, the parallelism of the planet's axis in every part of its orbit. It occurred to the contriver of the mechanism in question, before he had ever seen Mr. Adams's "Geometrical and Graphical Essays," and before he had heard of "Suardi's Geometric Pen," that if a small arm were by any means made to revolve in a retrograde direction, when placed at the distant end of the

long arm, or radius vector of any planet, during the time that the radius vector itself revolved just once by a direct motion round the sun in the centre, the curve traced by a pencil placed at the remote end of the small arm would be an *eccentric circle*; and also that there would be an alternate acceleration and retardation of angular velocity in the pencil with respect to the sun, or central point round which the radius vector might be carried; which velocity would be the quickest when the pencil was in its nearest situation, and slowest when most remote; because in the former case, the compound motion would be the sum of two motions, both in the same direction, and in the latter the difference of two motions in contrary directions. This idea, having at the moment of its occurrence made a strong impression on the mind of the inventor, excited in him much impatience to have it brought to the practical test of an experiment; the small frame, shewn in *fig. 3.* was roughly put together, and the equal wheels  $A$ ,  $B$ , and  $C$ , were included, so that  $A$  was fast to the arbor  $S$ , but  $B$  and  $C$  revolved on their arbors in the frame; the arbor of the latter, however, was left long enough for its pivot to protrude downwards, and to receive a crank-piece  $P$ , bearing a short pencil: the stem or arbor  $S$ , having its conical point at  $S$  fixed on a sheet of paper, was then held fast by a milled nut above it, to prevent its revolving, and the frame was carried round while the three small wheels, with equal numbers of teeth, were connected together; the consequence was, as had been expected, that the pencil traced a circle of a diameter equal to twice the distance of the arbors  $A$  and  $C$  from each other, but the centre of the circle was found to be at  $G$  instead of  $S$ , just the length of the short arm or crank-piece  $P$ , from the point  $S$ , from which the eccentric circle was described. This fact determined at once that the frame and short arm ought to be to each other in length as the mean distance is to the eccentricity of the orbit of any planet thus to be described, and, as orbits with but little eccentricity are very nearly *eccentric circles*, a circle thus described cannot be discriminated in a machine from an ellipse of the same eccentricity.

Before we proceed to describe the mechanism resulting from the principle of a little arm revolving backwards on the end of the radius vector of any planet just once in each revolution of the planet, let us illustrate the principle itself more clearly. Suppose the line  $AC$ , in *fig. 4. of Plate III.* to represent the length of the frame or radius vector  $SC$ , and also the short arm  $CA$ , representing the eccentricity or distance from the centre to the focus of the orbit, to be both directed into one right line  $SA$ , before any motion be communicated to the frame; then as the teeth of the three wheels  $A$ ,  $B$ , and  $C$ , of equal numbers of teeth, are connected together, and the wheel  $A$  is at rest, the wheel  $B$  will have a motion in the same direction as the frame, and the wheel  $C$  will have its motion in a contrary direction, but of the same velocity; conceive the centre of the wheel  $C$  to be carried along the circumference of the concentric circle  $COIE$ , the space of the quadrant  $CO$ , this wheel  $C$  by means of its connection with the wheel  $A$ , through the medium of wheel  $B$ , will in the same time have made a quarter of a revolution, and the remote end of the small arm attached to this wheel will be at  $N$ , at right angles to the radius vector, after having passed along the quadrant  $AN$ , of the eccentric circle  $ANPE$ , of which the point  $G$  is the invisible centre, and during the whole continuance of these two equal but contrary motions of the radius vector and short arm, through these quadrants respectively, the latter will have preserved itself parallel to its original situation  $AC$ ; again, while the radius vector is moving through the three remaining quadrants of the concentric circle

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circle from O to I E and C, successively, the remote end of the small arm will describe the three corresponding quadrants of the excentric circle from N to P, M, and A, in equal portions of time, and its parallelism will still be preserved throughout the whole circle, as seen in the figure. Thus, while the centre of the wheel C describes the concentric circle COIE round the point S with an equable motion, the remote end of the small arm, supposed to carry a planetary body, will describe the excentric circle ANPM, during the whole of which time the motion of the planet will be equable as it respects the point G or centre, but unequable as it respects the point S out of the centre, where the sun is supposed to be placed: for conceive lines like SN to be drawn from S to the planet in different parts of the circle ANPM, or orbit, and they will intersect the circle COIE behind the remote end of the radius vector in one half of a revolution, and before it in the other, and the angle at S, subtended by the short arm in any situation, will express the equation of the centre in that point of the orbit, which equation, therefore, is additive to the mean motion of the radius vector in one six signs of anomaly, and subtractive from it in the other six. The nature of the alternate retardation and acceleration of motion produced by this mechanism round the point S, and also the variation of distance, may be easily apprehended by attending to the successive retrograde and direct motions of the arm in each revolution of the radius vector; from A to N these move in opposite directions, and the difference of their velocities, as viewed from S, is equal to the quantity of retardation in any particular point of this quadrant; at N the difference is nothing, in which situation of the arm the equations would be a maximum if the arm were perpendicular to the line SN, i. e. if SN were a tangent, to the circle of which the arm ON is radius; but this will not happen till the radius vector has advanced beyond the space of an exact quadrant, and the arm has come to *n*, where the angle subtended at S by the arm will be the greatest possible.

The distance of this point, where the equation is a maximum from 90° of mean anomaly, will evidently depend on the relative proportions in length of the radius vector and short arm, or which is the same thing, of the mean distance and excentricity of the planet to be represented. From *n* to P, through the remainder of the first semi-circle, the radius vector and arm will both move in the same direction, and will cause an acceleration which will be greatest at P, the perihelion point, where they will both be again in a right line, shortened by double the whole length of the short arm, as compared with the original situation at the aphelion point. From the perihelion to the point of greatest equation at the opposite side of the orbit, the motions of the radius vector and arm continue to be in the same direction, but through the last quadrant and a small portion of the third, the directions are again opposite till the planet arrives at the aphelion point A, where it has undergone all its changes of velocity and distance, and where it commences the same alternation of slow and quick motions that were before exhibited.

Thus, if S be considered as the sun, A the place of the aphelion of any planet, P its perihelion, *m* and *n*, in the small circle of the arm, the places of mean motion, the concentric circle COIE the ecliptic, and the excentric one ANPM the planet's orbit, it is evident that both the excentricity, and also a certain equation of the centre of a planet's orbit, may be very conveniently represented by the same apparatus that has long been used for no other purpose but that of preserving the parallelism of its axis.

But still the main question is not disposed of; viz. what

portion of the equation, considered as an arc of the orbit, will a line equal to the excentricity subtend? The analogy for resolving this query is as follows:

As the mean distance, or radius vector, of the planet,  
Is to radius,

So is the excentricity, or short arm,

To the sine of the greatest angle at S subtended by the short arm.

This angle, taken in degrees and minutes, we find is invariably, as nearly as may be, *one-half of the greatest equation*, as has been already mentioned.

It will now have occurred to the reader, probably, that, if a line equal to the excentricity subtends one-half the equation of the centre of a planet, double the excentricity will be the measure of a short arm that will subtend the whole equation; this is nearly true as to the question of the equation alone, but then the distances and excentricity of the orbit, on which the geocentric appearances depend, would be greatly out of proportion; and what is gained in the heliocentric apparent places would be lost in the geocentric appearance in the system. To keep all the desiderata within their due bounds, and to make the elements of the orbit accord with both heliocentric and geocentric appearances in the mechanical representation, an additional contrivance was superadded, which supplied the defect of the revolving short arm without deranging materially the effect of its operation; the last wheel of the train, which carries the radius vector round in the due period, had its teeth so unequally cut as to represent the second half of the equation, by causing an alternate acceleration and retardation in the revolution of the radius vector itself, so that the total effect produced by these two contrivances acting together was very nearly agreeable to the real motion of the planet itself in its own orbit. But we have said, that the latitude of the planet was represented by the same contrivance that shews the distances and one-half of the equation. This was done by placing the stem of the planet in a square socket, at the remote end of the small arm, in so detached a way, that it was at liberty to rest on the plane of an inclined plate, carried by the radius vector, to represent the inclination of the orbit, and to receive the circular scale of latitudes pointed to by the end of the stem as it travelled up and down the said plane in its retrograde revolution.

The little frame we have had occasion to mention might do very well as a piece of mechanism for a radius vector, where the length is small, but where the planet is represented as moving at a considerable distance from the sun, the mechanism contained in *fig. 3. of Plate IV.* is better adapted, where A B is the radius vector proportional to the mean distance, and embracing fast the upper extremity of the tube of the wheel with unequal teeth; C is a contrate wheel of any number of teeth made fast to a surrounding tube that has no motion; the horizontal arbor D has two pinions of equal numbers, no matter what, one of which, E, is connected with the fixed wheel C, and the other, F, is connected with a second contrate wheel G, which is every way like the wheel C, except that its position is inverted for the sake of making its direction of motion retrograde; the lower pivot of wheel G rests in a cock H, attached to the end of the radius vector, and its upper pivot ascending above the same carries the short arm that supports the stem of the planet; lastly, I is the inclined plate with a scale of latitudes, on which the end of the stem rests, and by which it is made to ascend through one portion of its orbit, after which its own weight brings it gradually down again. The inclined plate is so placed that the nodes may fall at their

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respective distances from the aphelion point; and all the changes of place arising from the combined causes of varying distance, varying velocity, and inclination of the orbit, are duly represented.

A similar combination of mechanical contrivances was afterwards, in the year 1802, adopted by Mr. Pearson, when he contrived and superintended the construction of the large planetarium at the house of the Royal Institution in Albemarle Street, London; though the means are somewhat different. The plane of the instrument was desired by Dr. Thomas Young, at that time the lecturer, to be vertical instead of horizontal, which afforded the means of making the short arms, representing the respective excentricities revolve backwards by a weight suspended to each, instead of the wheel-work which we have described: the inequalities among the teeth of the tubed wheels in this instrument effect one half of the equation, and the retrograde revolutions of the little arms produce the other, and make all the planets revolve according to equated motion, while the stems round which the said short arms revolve are, agreeably to Dr. Young's suggestion, so bent, as to represent also the inclination of the orbits, and consequent heliocentric latitudes, for estimating which the ecliptic plate is put exactly in the plane passing through the centre of the sun, or coincident with the plane of the earth's orbit. The small divided plates carried by the ends of the radii vectores indicate both the equations and heliocentric latitudes; which observations we make here, because the construction of the instrument has never yet been publicly explained, except perhaps partially in the lectures, and because the uses of the different parts, not being obvious by mere inspection, are as yet but little understood. For a more particular description of this instrument, see our article PLANETARIUM.

But we are not to take for granted, because one half of the greatest equation will be thus represented at the point of mean distance by a radius vector and short arm, that are to each other as the mean distance to the excentricity, that therefore half the equation will be equally well represented in every other part of the orbit of a planet. Let us examine this matter more particularly, and bring it to the test of actual calculation. Let the line  $SH$ , *fig. 5. of Plate III.* be the radius vector of Mercury, and  $HA$  the short arm representing the excentricity, which are to each other very nearly as 5 to 1; then when the planet is at  $A$ , its greatest distance from  $S$ , the sun, it is obvious from what has been said, that its angular velocity, as it respects  $S$ , must be slower than if it were at  $P$ , or any other part of the line  $SA$ ; conceive now the point  $H$ , round which the little arm revolves, to move forwards so far that the planet may fall back by means of the arm to the point  $a$ ; then if a line were drawn from  $S$  to  $a$ , the equation or angle at  $S$  would be subtended by  $ab$ , the sine of the angle  $AHa$  to radius  $AH$ , which line consequently is perpendicular to the radius vector at the point  $b$ ; the distance  $bH$  is the cosine of the same angle, and we have  $SH + Hd$  for the base of a right-angled triangle, and  $ba$  for the perpendicular of the same, to determine the angle at  $S$  or semi-equation, which is one of the simple cases in plane trigonometry, where the base is used as radius, and the perpendicular as tangent of the required angle. For example, the mean distance of Mercury, as given by La Lande, is 38710, and its excentricity 7955.4, the mean distance of the earth being 100000; then if, agreeably to this ratio, we take the small arm representing the excentricity at unity, the radius vector must be 4.86587; for as 7955.4 : 38710 :: 1 : 4.86587; let the point  $a$  now be taken equal to  $30^\circ$  from  $A$ , and from the tables of natural

sines we have  $ab = .500000$  and  $SH + Hd = 4.86587 + .8660254 = 5.7318954$ , hence  
 As log. 57319 - Ar. co. - .2417014  
 Log. 5000 - - - - .6989700  
 Tang. of  $\frac{1}{2}$  equation  $4^\circ 59' 7''$  . 9406714

In the same manner one half of the equation, corresponding to any other point  $c$  in the quadrant  $AQ$ , may be found where  $Hd$  is the cosine to be added to the radius vector, and  $cd$  the sine which constitutes the subtense of the required angle at  $S$ . In the second quadrant from  $Q$  to  $P$  the radius vector minus the cosine becomes the base of the triangle at any point  $e$  or  $g$ , but the sines at those points are the perpendiculars  $ef$  and  $gb$ , as in the last quadrant, so that the base of the triangles successively taken is constantly shortening from the aphelion to the perihelion points of the orbit, whilst the perpendiculars are increasing in the first quadrant, and then decreasing in an inverted order in the second, which circumstance makes the equation greater in a given quantity of mean motion near the perihelion than near the aphelion, as the Newtonian theory requires. That a due estimate may be had of the effect produced by this mechanism in every part of Mercury's orbit, we shall subjoin a small table containing the data and result of corresponding calculations for every ten degrees of mean motion; and parallel to the semi-equations so obtained, we shall put a parallel column of half the equations taken from the best tables as published by La Lande, from which it will be seen that the errors, which at most are a small portion of the whole equation, are in excess from the aphelion or  $0^\circ$  to  $102^\circ$  of mean anomaly, and in defect from  $102^\circ$  to about  $258^\circ$ , then from  $258^\circ$  to  $360^\circ$  or  $0^\circ$  again in excess, which deviations from the truth are agreeable to the deviations arising from the approximation called the "elliptic hypothesis," which Buhald proved from four observed places of the planet Mars, as observed by Tycho Brahe, makes the computed places more backward than the true ones in the first and third quadrants of mean motion, and more forward in the second and fourth.

TABLE.

Dist. from the Aphelion	Base Line.	Perpendicular.	Dist. from the Aphelion	Corresponding Semi-Equations by Mechanism.	Semi-Equations by La Lande.
0	586587	00000	360	0 0 0	0 0 0
10	585068	17365	350	1 41 52	1 37 44
20	580556	34202	340	3 22 17	3 14 1
30	573190	50000	330	4 59 7	4 47 21
40	563191	64279	320	6 29 47	6 16 11
50	550866	76604	310	7 55 0	7 38 49
60	53687	86603	300	9 10 5	8 53 26
70	520789	93969	290	10 13 41	9 58 0
80	503952	98481	280	11 3 26	10 50 16
90	486587	100000	270	11 36 48	11 27 43
100	469222	98481	260	11 51 2	11 47 34
110	452385	93969	250	11 44 5	11 46 54
120	436587	86603	240	11 14 41	11 22 44
130	422308	76604	230	10 16 52	10 32 23
140	409983	64279	220	8 53 25	9 14 3
150	399984	50000	210	7 8 30	7 27 35
160	392618	34202	200	4 58 2	5 15 24
170	38816	17365	190	2 23 42	2 43 13
180	386587	00000	180	0 0 0	0 0 0

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In examining the preceding table it may be seen that the place of mean motion, or point where the equation is a maximum, falls, according to the mechanism, somewhere between  $100^\circ$  and  $110^\circ$ , which, in La Lande's tables, is at  $105^\circ$ ; let us try where it will fall exactly by the mechanical representation.

The point B, where the line SB is a tangent to the small circle, is the place of the planet's greatest equation, and this point will be found beyond the first quadrant, a quantity equal to the angle QHB, or, which is the same thing, HSB, or greatest semi-equation; for as SHQ and SBH are both right-angled, and have the angle at S common to both, the third angle, HQS, is equal to the third angle BHS, and, consequently, the supplemental angle QHB is equal to the supplemental angle HSQ, or greatest semi-equation. *Q. E. D.*

But the greatest semi-equation by the mechanism when computed is  $11^\circ 51' 34''$ , therefore the place of mean motion falls at  $90^\circ + 11^\circ 51' 34''$ , or at  $101^\circ 51' 34''$ , which point is short of  $105^\circ$  by a quantity upwards of  $3^\circ$ . This want of exact coincidence is, however, of little or no moment in the mechanical representation of the orbit, because the quantity of the greatest equation is nearly stationary for many degrees both before and after the exact point of mean motion. The representation will be still more accurate where the orbits have less excentricity, than that of Mercury, which is the case with all the other planets, except two out of the four newly discovered ones, *viz.* Pallas and Juno.

As we have had frequent occasion in this article to speak of a wheel with unequal teeth, made for the purpose of effecting alternate accelerations and retardations of angular motion, and have also seen the theory explained by Mr. Huygens, it may be proper to say a few words here about the practical method of cutting such a wheel. This operation may be done by three different methods; first, the divided circle of the plate, to be used with the engine, may have the divisions laid down unequally by Huygens' mode of transferring equal divisions from an excentric circle to a concentric one, as already explained; and then the teeth may be cut in the ordinary way from these unequal spaces, when punched or drilled into dividing holes; or, secondly, an equally divided circle of the engine plate may be used, and the increments and decrements, previously calculated, may be given at each tooth by the micrometer screw of such an engine as either Hindley's or Rehó's; or, thirdly, which is the readiest method, the wheel to be cut may have a hole drilled in the excentric point, and be placed thereby on the arbor of the engine, till all the teeth are marked with slight notches by the cutter, adjusted for distance at each cutting, and then the hole in the centre must be used for completing the teeth in their proper direction; for when the cutter is put into the notches successively, it will cut the teeth towards the centre without any guidance of the index or alidade; and this method is practicable with any common engine without a micrometer screw for taking and giving small portions, as deductions from or additions to a mean tooth. For the wheels with unequal teeth in the large planetarium of the Royal Institution, in Albemarle street, London, the first method was used by the maker, McCulloch, under the direction of the contriver both of the machine itself, and of the method used of rendering the teeth of certain wheels gradually unequal round each separate semicircle, agreeably to the planetary motions to be produced thereby in the planets themselves; but in an accurate and elegant machine since made (by Fidler) for himself, the last method was used with success for the large

wheel that produces the sun's, or rather earth's annual equation.

Another, and that a very recently contrived method of exhibiting the equations of all the planetary orbits at the same time, together with their variable distances, by very simple mechanism, has been adopted by Mr. Pearson in the machine we have just mentioned, as made by Fidler, under his own direction; this method has the advantage of shewing also the mean motions, and is well calculated for illustrating the irregularities of motion on which the various phenomena of the heavenly bodies depend, as well as for shewing the exact times at which they occur, and the countries to which they will be visible. For a description of the machine itself we refer the reader to the articles PLANETARIUM and ORRERY, and satisfy ourselves in this place with an account of the principle by means of which the equations of the centre are effected. *Fig. 1. of Plate IV. of Planetary Machines*, which is illustrative of the principle in question, is derived from *fig. 4. of Plate III.* which has been explained, but has the addition of a third diminutive arm at the end of the longer arm placed at the extremity of the radius vector; we have seen that one arm, equal in length to the excentricity of the orbit to be represented, will, by its retrograde revolution, give the distances and one half of the equation, very nearly, in every part of the orbit, and we have seen that if the said arm were made equal to twice the excentricity it would give the whole equation near enough, but would not give the distances truly; now the introduction of the additional arm is to make the apparent place of the planet fulfil both these conditions, which it does in a surprising manner. Let S-J, in *fig. 2.* be a radius vector, revolving equably round the point S, in *fig. 1.* in which case the extreme end J will describe the concentric circle JKOLQRTV; let Ja be a short arm equal in length to the excentricity once and a half taken, which arm is made to revolve in a backward direction by means of the fast grooved circle *d*, of the catgut *ef*, and of the pulley *g* of the same diameter as *d*, which mechanism answers as well as that in *fig. 3.* before described, and is simpler: over the pulley *g* is fixed fast to a stem, borne by the radius vector, round which the pulley turns, another grooved circular piece J, round which the gut *bi* goes, and embraces also a diminutive pulley *a* of half the size of J, so that whilst the radius vector and arm Ja go each once round in contrary directions, the third or little arm aA, which is equal in length to only one half the excentricity, goes twice round in the same direction, in which the radius vector moves, and thus carries a planet at its extremity round the point S, in which the sun is placed, very nearly agreeably to the laws of planetary motion, with regard both to angular velocity and distance in every part of the orbit. To render the effect thus produced more intelligible, conceive two pins made fast in the line JA, *fig. 1.* considered as one line equal to twice the excentricity of the orbit to the radius SJ, and let one of them be at C, the middle of the line, and the other at A, the extremity; then if this line preserves its parallelism all round the orbit, by a retrograde motion given to it by the catgut *ef* and pulley *g*, *fig. 2.* the pin C being at the distance of the excentricity SG from the end J of the radius vector, will describe the excentric orbit 1, 2, 3, I, 4, 5, 6, of the planet, while the pin at A will have the proper velocity as seen from S, but will move in the circle ABDEP FMH, which is too excentric to become the true orbit; but if the point A of the additional small arm be put to C when the motion begins, and has the planetary body placed on its extremity, then it will move in the same excentric

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circle as the first pin C, but with the apparent angular velocity of the second pin A as seen from the other focus W, and very nearly so as seen from the sun at S: for conceive the radius S J to have moved to K, the pin A will be found at B, on account of the angle B K b being equal to the angle J S K, which is here  $45^\circ$ , but the planet has moved a quadrant to 1, and is found in the circle described by the pin C, or middle circle; but, viewed from W, according to the elliptic hypothesis, is seen in the line W B, as though it had been actually at B in the outermost circle; again, when the radius vector has completed a quadrant and is in the situation S O, the first pin is at N, the second at D, and the planet at 2, in the line W D as before, and the additional arm has now described a semicircle: here the equation D S O is subtended by double the excentricity very nearly: when J is advanced  $135^\circ$  to L, the additional arm has moved  $\frac{3}{4}$  of a circle, and is found at 3, still in the middle circle, and also in the line W E, extended: and when S Q is the situation of the radius vector the planet is at I, the perihelion point of the middle circle, and also in the line W P, extended as before. In like manner in the other semicircle of mean anomaly, when the extreme end of the radius vector is successively at the points R, T, and V, the planet will be found at the points 4, 5, and 6, and also in the lines W F, W M, and W H, respectively, still moving in the middle circle, till it arrives at the aphelion point C, from which it originally set out. When the pulleys are made to produce this effect very nicely, the band or gut, that embraces two pulleys of different diameters, will affect the ratio of 1:2 in practice, and will require the smaller pulley to be somewhat less in diameter than what the exact proportion requires in theory. The radius vector has a slit in its remote end, with a thumb-screw under it, to fix the pulley at a greater or less distance, as the tension of the gut may require, and the whole contrivance being simple, steady in its motion, and light in its construction, as well as having a tendency to prevent the radius vector from bending downwards, is far preferable, in every point of view, to any contrivance we have before seen for answering the same purpose. The mechanical representation of the orbit bears the same analogy to the elliptic hypothesis, that an excentric circle does to an ellipse of the same excentricity, and in the orbits of the planets these figures are so nearly alike, that they may be substituted for each other, without sensible error; and we may add, that the equation produced by only one arm, equal to twice the excentricity, is by no means so accurate as the *equation doubled*, that is, produced from an arm equal to the exact excentricity, because the tangents of different angles do not increase by equal quantities.

Besides the preceding methods of producing the equation of a planet's orbit, our author has contrived to indicate the quantity thereof in any point of the orbit, as well as the latitude also, as seen from the sun; this is done by means of a hand fixed under the revolving pulley J, travelling over a divided and silvered plate, fixed fast in the situation of the dotted circle, on the end of the radius vector, concentric with the pulley, which plate not only shews the equation and latitude at any time, but is of use in placing the arms in their proper situations by the latitudes taken from the Ephemeris or Nautical Almanac.

These are all the methods that have fallen within our notice, of effecting the grand equation of a planet's orbit, as applied to an orrery, or planetarium; but there remain yet two pieces of mechanism, contrived by our present inventor, that are well calculated to explain in a lecture-room the equation of an individual planet, as detached from the system,

which we shall briefly describe, as being contrivances equally novel and competent to their purpose. The first is represented by *figs. 4 and 5* of our last plate, the former being a section of the wheel-work, and the latter a sketch of a part of the visible part of the instrument. AB is a little frame, containing four wheels, *a, b, c,* and *d*; *a* and *b* are equal in diameter, and of similar numbers of teeth, *a* fixed on the arbor of the handle *e,* and *b* on a tubed arbor *f,* that carries the index *g,* seen in *fig. 5* of the shape of a T, with a point touching the circle *k,* which is an elliptic circle; so that whatever velocity is given by the handle to the wheel *a* in an equable manner, the same is communicated, by the medium of the wheel *b,* to the index *g,* which therefore moves according to mean motion in the elliptic circle K. The wheels *c* and *d* are excentric, and have also similar diameters and numbers of teeth, but are placed to act so, that the longest radius of one always acts with the shortest of the other, and thus produce the same effect as Dr. Desaguliers' elliptic grooved plates with the endless catgut. The excentricity of the wheels bears the same proportion to their common radius, that the excentricity of the planet's orbit does to its mean distance: wheel *c* is fixed fast to the same arbor of the handle as wheel *a* is, but wheel *d* has a separate arbor, which goes with the tube of wheel *b,* and carries the hand *i,* and on its upper end a ball to represent the sun. The sectoral arc of the index *g* is graduated, for Mercury for instance, into  $24^\circ$  each way from the middle, to which the hand *i* must be put when the index points to that part of the elliptic circle in which the aphelion point of the planet is; then as the handle is turned the index shews the mean motion in the elliptic, which may have a second circle divided into signs of mean anomaly, beginning at the aphelion point, and as the motion proceeds the hand *i* falls back, till at the end of three signs and a half of mean anomaly it is found near the extremity of the sectoral arc, at *g*; at the perihelion point the hand is again in the middle; and at eight and a half signs of mean anomaly it will be in its present situation again, at its greatest equation, at the opposite end of the sectoral piece; and lastly, at the aphelion point the hand will be again found in the middle, which is the zero of both the positive and negative equations, which are respectively marked + and - on the opposite ends of the graduated sectoral arc. Thus, the index *g* shews the mean motion, the hand *i* the equated motion, and the graduated portion of the index has the quantity of the equation plus or minus, shewn by the hand *i* in every part of the orbit, while a line drawn from S, the sun, over the point of the hand *i* to the elliptic K, shews the equated or true heliocentric place of the planet. The other instrument for explaining the nature of the mean and equated anomaly of a detached planet, and of its equation, which is their difference, is simply a mechanical construction of the elliptic hypothesis of bishop Ward, and is represented by *fig. 6* of the same plate. S G W is an elliptic plate of wood or metal, described from the foci S and W, the small circle at S is divided into an elliptic circle with a slender stem in the centre bearing a ball to represent the sun, and the other similar circle at W is divided into as many spaces as there are days or weeks in the period of the planet; of which 88<sup>d</sup> are proper for Mercury; the bar *a* G is concealed under the dotted line, and turns on the vertical stem of the stand that supports the elliptical plate at G, by means of a piece of brass tube fixed at its end; on the bar *a* a sliding piece *b* is inserted, that bears a small pulley *c,* and a planet in the angular point behind it, on a stem as high as that of the sun; this sliding piece has two rollers, bearing against the edge of the elliptical plate, to facilitate the motion of the bar round the plate, which is produced by

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hand; an endless gut or silk cord  $S W c$  draws the sliding piece close to the said plate, and causes the pulley and planet to describe the proper ellipse for the orbit. According to the elliptic hypothesis, if the angle  $c W A$  be the measure of the mean anomaly, the angle at the sun in the other focus, *viz.*  $c S A$ , will always be the equated anomaly, and the small angle  $S c W$  will, in every situation, be the equation of the centre, as being the supplement of the sum of the other two angles, that is, the external angle  $c W A$ , that represents the mean anomaly, is equal to the sum of both the internal angles of the triangle at  $S$  and  $c$ , as being respectively the supplement of the other internal angle at  $W$ ; but the internal angle at  $S$  is the equated anomaly; therefore the angle  $c W A - \angle c S W$  is the angle  $c$ , or equation during the first six signs of mean anomaly; in the other six signs the angle representing the mean anomaly at  $W$  will be smaller than the angle at  $S$ , representing equated anomaly, therefore the equation, or difference between them, which has been subtractive, becomes now additive; and the hypothesis, thus mechanically constructed, affords the ready means of explaining the particulars of planetary motion, for which purpose equal sectoral arcs are laid down on the plate alternately black and white, which the thread  $S c$  moves over in equal arcs of the circle  $W$ , moved over by the thread  $W c$ ; which are equal portions of time; and when the circle  $W$  is divided into days or weeks, and the circle  $S$  into signs of longitude, and also into signs of anomaly, the same results will follow as from the preceding mechanism, as nearly as may be, while, at the same time, all the variations of distance, as well as of the equation, will be faithfully exhibited. Both these contrivances may be constructed so as to be used either horizontally or vertically, and on any scale of magnitude that the audience of a lecture room may require.

*EQUATION of Time.* Having, under the article *DAY*, explained the origin of the difference between solar and mean time, we have now only to explain the method by which this difference is calculated.

To effect this, it is necessary to know precisely the motion of the sun, and the dimensions of its orbit: we may then calculate the arc which it describes every day in the year parallel to the equator. If this real and variable motion be compared with its mean motion, the difference will be the equation of time.

If we imagine two meridians, drawn through the two extremities of the arc of the ecliptic, which the sun describes in one day, the arc of the equator, which they intercept, is the difference between the solar and a sidereal day; for when the rotation of the celestial sphere is terminated, this small arc of the equator must traverse the meridian before the centre of the sun can arrive there. Now as this arc is not always of the same length, the solar days are not all equal.

Nor would they be so, even if the sun described every day an equal arc of the ecliptic, for these arcs take successively different inclinations relatively to the equator. At the moment of the equinoxes, they cut this plane at an angle equal to the obliquity of the ecliptic, and at the period of the solstices they are parallel to it. The meridians drawn through the extremities of these diurnal arcs are more separated at the solstices than if they contained the same arc at the time of the equinoxes; and, as it is this separation of the two meridians which measures the successive retardations of the sun, these are unequal, and less at the equinoxes than at the solstices. The daily variation of the motion of the sun in its orbit is another source of inequality, as it augments and diminishes the diurnal arc of the ecliptic, and this produces a corresponding variation in the arcs of

of the equator contained between the above-mentioned meridians.

Thus the inequality in the solar days arises from two distinct causes, the obliquity of the ecliptic, and the unequal motion of the sun in its orbit. As these two causes each produce their separate effect, they must be both destroyed, to render the solar days equal, that is, the motion of the sun must become uniform, and the ecliptic must coincide with the equator.

To calculate the value of the equation of time, we must calculate the arc which the sun describes each day on the ecliptic, and project it on the equator, and from this deduct the mean diurnal motion: the difference will give the equation of time for that day.

To represent these results geometrically, we may suppose an artificial sun to move in the manner described under the article *DAY*, the mean day is the interval between two successive returns of this fictitious sun, and the mean noon the instant of its passage over the meridian; and the mean equinox is the instant of its passage through the equinoctial point. It is obtained by a simple proportion, when the longitude of the perigee is known, and the epoch when the true sun is in the apses, the time which elapses between two consecutive returns to the mean equinox, forms the mean tropical year, and which is equal to 365,<sup>d</sup> 242250.

To calculate the place of the mean sun on the equator for a given instant, it is sufficient to calculate the mean longitude, and this, reduced to the equator, is the mean right ascension of the sun.

The projection of the true sun on the equator may either be determined from observation; or from calculating its right ascension. The difference between their right ascensions, reduced into time, in the proportion of 24<sup>h</sup> to 360°, indicates the interval between the passage of the true and mean sun, and is the required equation of time: it is sometimes additive, and sometimes subtractive, and has the remarkable property of becoming zero four times in a year.

To understand the reason of this phenomenon, let us imagine (*fig. 108.*) two suns,  $S^2$  and  $S^1$ , to set out at the same time from the equinox, both moving with an uniform motion; the one,  $S^2$ , in the ecliptic, the other,  $S^1$ , in the equator, and let the motion of each be referred to the latter plane.  $S^2$  will at first advance upon the meridian of  $S^1$ , but afterwards this latter will approach it, and they will arrive together at the solstice; after this the meridian of  $S^2$  will advance upon that of  $S^1$ , till the second equinox, where they will arrive together. The same circumstances will occur in the other half of the orbit, and thus the two suns will coincide together four times in the year, namely, at the equinoxes and solstices.

But, in reality, the mean sun does not set out at the same time as the true sun; they will not, therefore, meet at the same points; the unequal motion of the sun changes this difference, but these two causes united only change the epoch of the coincidences; their number remains the same.

Let us consider the motion of the two suns,  $S^2$ , and  $S^1$ , supposed to set out together from the autumnal equinox, and proceeding towards the perigee. The true sun,  $S^1$ , which describes the ecliptic, being referred by its meridian to the plane of the equator, will then be found behind the others, for it is preceded by  $S^2$  till the perigee; let us now consider the motion of the other two. Till the moment of the solstice,  $S^2$  precedes  $S^1$ , and  $S^2$  precedes  $S^1$ , their order is therefore  $S^1, S^2, S^1$ . At the solstice  $S^1$  joins  $S^2$ , and afterwards passes it; their order is then  $S^2, S^1, S^2$ , but at the perigee  $S^1$  coincides with  $S^2$ , and afterwards precedes it: to do this  $S^1$  and  $S^2$  must meet in the interval. The order then becomes  $S^1, S^2,$

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$S^2, S^1$ ; thus between the winter solstice and the perigee the true sun  $S^1$ , referred to the equator, meets the mean sun  $S^2$ , and the equation becomes zero. From the perigee to the vernal equinox  $S^1$  precedes  $S^2$ , and  $S^2$  precedes  $S^3$ ; they none of them meet therefore in this interval. At the equinox  $S^1$  joins  $S^2$ , and their order becomes  $S^2, S^3, S^1$ ; but  $S^3$  cannot remain long between the two others, for at every quadrant the separation of  $S^2$  and  $S^3$  increases to  $2^\circ 24' 24''.4$ , as appears by calculation; but the distance of  $S^1, S^2$  never exceeds  $1^\circ 55' 27''$ , which is the greatest equation of the centre, and as, in the present situation of the solar orbit, this takes place near the equinoxes, the arc which corresponds to it on the equator is still less than it. It is evident, therefore, after the vernal equinox, and before the summer solstice, there must be some moment when the mean sun  $S^2$  arrives upon the meridian of  $S^1$ , when the equation is again zero. From that point to the summer solstice the order is as follows,  $S^2, S^1, S^3$ : at the solstice  $S^2$  joins  $S^1$ , and afterwards passes it. But  $S^1$  precedes  $S^2$  as far as the apogee, consequently the meridian of  $S^1$  joins the mean sun  $S^2$ , before the solstice, and the equation becomes zero for the third time.

From the solstice to the apogee, the order of the three suns is as follows,  $S^1, S^2, S^3$ ; at the apogee  $S^2$  joins  $S^1$ , and afterwards precedes it till the perigee, the order thus becoming  $S^1, S^3, S^2$ ; but at the autumnal equinox  $S^2$  joins  $S^3$ , and consequently meets in this interval the meridian of  $S^1$ , and the equation becomes zero for the fourth time.

The order of the three suns then becomes  $S^1, S^2, S^3$ , and the same appearances are re-produced in the same order as before.

Hence it appears, that in consequence of the obliquity of the ecliptic, combined with the unequal motion of the sun, the equation of time becomes zero four times a year, *viz.* once between the winter solstice and the perigee, twice between the vernal equinox and the summer solstice, and for the last time between the apogee and the autumnal equinox. The epochs of these phenomena evidently vary with the position of the greater axis of the solar orbit; at present they happen about the 24th December, 15th April, 15th June, and the 31st of August. If the equator coincided with the ecliptic, that part of the equation of time depending on their inclination would disappear, and the mean motion would only differ from the true by the equation of the centre, and mean and true time would agree twice a year when the sun is in the apsidæ.

Dr. Maskelyne has invented a rule for computing the equation of time, in which all the three causes are considered; it was investigated in the following manner.

Let  $A P L Q$  (*Plate XII. fig. 109.*) be the ecliptic,  $A L Q$  the equator,  $A$  the first point of Aries,  $P$  the point where the sun's apparent motion is slowest,  $S$  any place of the sun; draw  $S v$  perpendicular to the equator, and take  $A n = A P$ . When the sun begins to move from  $P$ , suppose a star to begin to move from  $n$ , with the sun's mean motion in right ascension or longitude, *viz.* at the rate of  $59' 8''$  in a day; and when  $n$  passes the meridian, let the clock be adjusted to 12; take  $n m = P s$ , and when the star comes to  $m$ , if the sun moved uniformly with his mean motion he would be found at  $s$ , but at that time let  $S$  be the place of the sun. Let the sun  $S$ , and consequently  $v$ , be on the meridian; and then as  $m$  is the place of the imaginary star at that instant,  $m v$  must be the equation of time. The sun's mean place is at  $S$ , and as  $A n = A P$ , and  $n m = P s$ , we have  $A m = A P s$ ; consequently  $m v = A v - A m = A v - A P s$ . Let  $A$  be the mean equinox, or the point where it would have been if it had moved with its mean velocity, and draw  $A z$  perpendicular to  $A Q$ : then  $A m = A z + z m = A a \times \cos z A a + z m$ : or because the cosine of  $z A a$ , the obliquity of the ecliptic  $23^\circ 28'' = \frac{1}{2}$  very nearly,  $A m = \frac{1}{2} A a + z m$ : hence  $m v = A v - z m - \frac{1}{2} A a$ . Here  $A v$  is the sun's true right ascension;  $z m$  the mean right ascension, or mean longitude; and  $\frac{1}{2} A a$  (*viz.*  $A x$ ) is the equation of the equinoxes in right ascension; therefore the equation of time is equal to "the difference of the sun's true right ascension, and his mean longitude corrected by the equation of the equinoxes in right ascension."

When  $A m$  is less than  $A v$ , mean or true time precedes apparent; when it is greater, apparent time precedes mean: that is, when the sun's true right ascension is greater than his mean longitude, corrected as above shewn, we must add the equation of time to the apparent to obtain the mean time; and when it is less we must subtract. To convert mean time into apparent, we must subtract in the former case, and add in the latter.

Tables of the equation of time are computed by this rule for the use of astronomers; they are either calculated for the noon of each day, as given in the Nautical and some other Almanacs, or for every degree of the sun's place in the ecliptic, as is done in the annexed tables.

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## TABLE

Of Equation of Time to convert apparent into mean Time for 1810, with the secular Variation.

Argument.—Sun's mean Longitude:

Deg.	Sig. O.		Diff.		Secular Variation.		Sig. I.		Diff.		Secular Variation.		Sig. II.		Diff.		Secular Variation.	
					±						±							±
0	+	6	59.2	18.8	2.97	25	-	1	31.2	12.5	4.31	24	-	3	43.4	4.5	10.83	18
1		6	40.4	18.9	2.72	24		1	43.7	12.0	4.55	24		3	38.9	5.0	11.01	17
2		6	21.5	18.9	2.48	24		1	55.7	11.4	4.79	23		3	33.9	5.5	11.18	18
3		6	2.6	18.8	2.24	24		2	7.1	10.8	5.02	24		3	28.4	6.1	11.36	17
4		5	43.8	18.9	2.00	25		2	17.9	10.4	5.26	23		3	22.3	6.6	11.53	16
5		5	24.9	19.0	1.75	24		2	28.3	9.8	5.49	24		3	15.7	6.9	11.69	16
6		5	5.9	18.8	1.51	24		2	33.1	9.3	5.73	23		3	8.8	7.7	11.85	16
7		4	47.1	18.8	1.27	25		2	47.4	8.3	5.96	23		3	1.1	8.0	12.01	15
8		4	28.3	18.7	1.03	24		2	56.2	8.3	6.19	23		2	53.1	8.4	12.16	15
9		4	9.6	18.6	0.78	24		3	4.5	7.6	6.42	23		2	44.7	8.8	12.31	14
10		3	51.0	18.4	0.54	25		3	12.1	7.1	6.65	23		2	35.9	9.2	12.45	14
11		3	32.6	18.5	0.29	24		3	19.2	6.6	6.88	23		2	26.7	9.8	12.59	14
12		3	14.1	18.3	0.05	25		3	25.8	5.9	7.11	22		2	16.9	10.0	12.73	13
13		2	55.8	18.0	0.20	24		3	31.7	5.4	7.33	23		2	6.9	10.3	12.86	13
14		2	37.8	17.9	0.44	24		3	37.1	4.9	7.56	22		1	56.6	10.8	12.99	12
15		2	19.9	17.6	0.68	25		3	42.0	4.2	7.78	22		1	45.8	11.2	13.11	12
16		2	2.3	17.3	0.93	24		3	46.2	3.4	8.00	22		1	34.6	11.4	13.23	11
17		1	45.0	17.1	1.17	24		3	49.6	3.0	8.22	21		1	23.2	11.6	13.34	11
18		1	27.9	16.9	1.41	25		3	52.6	2.5	8.44	22		1	11.6	11.9	13.45	10
19		1	11.0	16.7	1.66	24		3	55.1	1.9	8.65	20		0	59.7	12.1	13.55	9
20		0	54.3	16.4	1.90	24		3	57.0	1.3	8.85	21		0	47.6	12.3	13.64	9
21		0	37.9	16.0	2.14	25		3	58.3	0.6	9.06	21		0	35.3	12.5	13.73	9
22		0	21.9	15.5	2.39	24		3	58.9	0.1	9.27	21		0	22.8	12.7	13.82	8
23	+	0	6.4	15.1	2.63	24		3	59.0	0.5	9.48	20	-	0	10.1	12.8	13.90	8
24	-	0	8.7	14.7	2.87	24		3	58.5	1.1	9.68	20	+	0	2.7	12.9	13.98	7
25		0	23.4	14.3	3.11	24		3	57.4	1.7	9.88	19		0	15.6	13.1	14.05	6
26		0	37.7	13.9	3.35	24		3	55.7	2.2	10.07	20		0	28.7	13.1	14.11	6
27		0	51.6	13.5	3.59	24		3	53.5	2.8	10.27	20		0	41.8	13.2	14.17	5
28		1	5.1	13.2	3.83	24		3	50.7	3.4	10.47	18		0	55.0	13.1	14.22	5
29		1	18.3	12.9	4.07	24		3	47.3	3.9	10.65	18		1	8.1	13.0	14.27	4
30	-	1	31.2		4.31			3	43.4		10.83			1	21.1		13.31	

# EQUATION.

## TABLE

Of Equation of Time to convert apparent into mean Time for 1810.

Argument.—Sun's mean Longitude.

Deg.	Sig. III.		Diff.	Secular Variation.		Sig. IV.	Diff.	Secular Variation.		Sig. V.	Diff.	Secular Variation.			
	+	"		+	"			+	"			+	"		
0	+	1 21.1	13.0	14.31	4	+	5 59.3	2.1	13.14	11	+	2 46.2	15.0	8.78	17
1		1 34.1	13.1	14.35	3		6 1.4	1.6	13.03	12		2 31.2	15.5	8.61	17
2		1 47.2	13.1	14.38	2		6 3.0	1.2	12.91	12		2 15.7	15.9	8.44	17
3		2 0.3	13.0	14.40	2		6 4.2	0.6	12.79	12		1 59.8	16.4	8.27	17
4		2 13.3	12.8	14.42	2		6 4.8	0.1	12.67	12		1 43.4	16.8	8.10	17
5		2 26.1	12.6	14.44	1		6 4.7		12.55	12		1 26.6		7.93	17
6		2 38.7	12.4	14.45	0		6 4.0	1.4	12.42	13		1 9.4	17.6	7.76	17
7		2 51.1	12.2	14.45	0		6 2.6	2.0	12.29	13		0 51.8	18.0	7.59	17
8		3 3.3	12.0	14.45	1		6 0.6	2.5	12.16	13		0 33.8	18.4	7.42	17
9		3 15.3	11.7	14.44	1		5 58.1	3.3	12.03	14	+	0 15.4	18.6	7.25	17
10		3 27.0	11.4	14.43	2		5 54.8	3.8	11.89	14	-	0 3.2		7.08	17
11		3 38.4	11.1	14.41	2		5 51.0	4.4	11.75	14		0 22.1	19.2	6.91	17
12		3 49.5	10.8	14.39	3		5 46.6	5.0	11.61	14		0 41.3	19.5	6.74	18
13		4 0.3	10.5	14.36	4		5 41.6	5.7	11.47	15		1 0.8	19.8	7.56	17
14		4 10.8	10.1	14.32	4		5 35.9	6.4	11.32	15		1 20.6	20.0	7.39	18
15		4 20.9	9.7	14.28	4		5 29.5	6.9	11.17	15		1 40.6	20.2	7.21	17
16		4 30.6	9.4	14.24	5		5 22.6	7.5	11.02	15		2 0.8	20.5	6.04	17
17		4 40.0	9.0	14.19	6		5 15.1	8.1	10.87	15		2 21.3	20.6	5.87	18
18		4 49.0	8.5	14.13	6		5 7.0	8.7	10.72	15		2 41.9	20.8	5.69	17
19		4 57.5	8.1	14.07	6		4 58.3	9.3	10.57	16		3 2.7	20.9	5.52	18
20		5 5.6	7.6	14.01	7		4 49.0	9.8	10.41	16		3 23.6	21.1	5.34	18
21		5 13.2	7.4	13.97	7		4 39.2	10.4	10.25	16		3 44.7	21.1	5.16	18
22		5 20.6	6.9	13.87	8		4 28.8	10.9	10.09	16		4 5.8	21.2	4.98	17
23		5 27.5	6.2	13.79	8		4 17.9	11.5	9.93	16		4 27.0	21.3	4.81	18
24		5 33.7	5.7	13.71	9		4 6.4	12.1	9.77	17		4 48.3	21.4	4.63	18
25		5 39.4	5.1	13.62	9		3 54.3	12.7	9.60	16		5 9.7	21.3	4.45	18
26		5 44.5	4.5	13.53	9		3 41.6	13.0	9.44	16		5 31.0	21.3	4.27	18
27		5 49.0	3.9	13.44	10		3 28.6	13.6	9.28	16		5 52.3	21.4	4.09	18
28		5 52.9	3.4	13.34	10		3 15.0	14.2	9.12	17		6 13.7	21.3	3.91	18
29		5 56.3	3.0	13.24	10		3 0.8	14.6	8.95	17		6 35.0	21.3	3.73	19
30		5 59.3		13.14			2 46.2		8.78	17	-	6 36.3		3.54	19

# EQUATION.

## TABLE

Of Equation of Time to convert apparent into mean Time for 1810, with the secular Variation.

Argument.—Sun's mean Longitude.

Deg.	Sig. VI.		Diff.	Secular Variation.		Sig. VII.	Diff.	Secular Variation.		Sig. VIII.	Diff.	Secular Variation.			
				±				—				—			
0	—	6 <sup>1</sup> 56.3	"	3.54	18	—	15 <sup>1</sup> 17.8	"	2.56	23	—	13 <sup>1</sup> 54.9	"	9.64	24
1		7 17.5	21.2	3.35	19		15 26.6	8.8	2.79	23		13 3 .9	16.0	9.88	24
2		7 38.5	21.0	3.17	18		15 34.7	8.1	3.02	23		13 22.	16.8	10.11	23
3		7 59.3	20.8	2.99	18		15 42.1	7.4	3.25	23		13 4.6	17.5	10.33	22
4		8 00.0	20.7	2.80	19		15 48.8	6.7	3.48	23		12 7.4	18.2	10.55	22
5		8 40.0	20.6	2.61	19		15 54.8	6.0	3.71	23		12 27.3	19.1	10.77	22
			20.4		19			5.2		23			19.9		21
6		9 1.0	20.1	2.42	19		16 0.0	4.4	3.94	24		12 7.4	20.6	10.98	21
7		9 21.1	19.9	2.23	19		16 4.4	3.7	4.18	24		12 46.8	21.3	11.19	21
8		9 41.0	19.7	2. 4	19		16 8.1	2.9	4.41	24		11 25.5	22.0	11.40	21
9		10 0.7	19.4	1.85	19		16 11.0	2.0	4.64	24		11 3.5	22.7	11.61	21
10		10 20.1	19.2	1.66	19		16 13.0		4.89	24		10 40.8	23.4	11.81	20
			18.8		20			1.2		24			23.4		20
11		10 39.3	18.8	1.46	20		16 14.2	0.5	5.13	24		10 17.4	24.0	12.01	19
12		10 58.1	18.4	1.26	20		16 14.7	0.5	5.37	24		9 53.4	24.5	12.20	19
13		11 16.5	18.0	1.06	20		16 14.2	1.3	5.61	24		9 28.9	25.2	12.39	19
14		11 34.5	17.7	0.81	20		16 12.9	2.1	5.81	24		9 3.7	25.8	12.58	19
15		11 52.2	17.3	0.66	20		16 10.8		6.09	24		8 37.9	26.4	12.77	19
			16.8		21			3.0		24			26.4		18
16		12 9.5	16.8	0.46	21		16 7.8	3.8	6.33	24		8 11.5	26.9	12.95	17
17		12 26.3	16.4	0.25	21		16 4.0	4.7	6.57	24		7 44.6	27.3	13.12	17
18		12 42.7	16.0	0.01	21		15 59.3	5.6	6.81	24		7 17.5	27.6	13.29	17
19		12 58.7	15.5	0.16	21		15 53.7	6.4	7.05	24		6 49.7	28.1	13.45	16
20		13 14.2	14.9	0.37	21		15 47.3		7.29	24		6 21.6	28.5	13.61	16
			14.4		22			7.3		24			28.5		15
21		13 29.1	14.4	0.58	22		15 40.0	8.3	7.53	24		5 53.1	28.8	13.76	15
22		13 43.5	13.9	0.80	21		15 31.7	9.1	7.77	24		5 24.3	29.2	13.91	15
23		13 57.4	13.4	1.00	22		15 22.6	10.0	8.01	24		4 55.1	29.5	14.04	14
24		14 10.8	12.8	1.23	22		15 12.6	10.9	8.25	24		4 25.6	29.7	14.19	14
25		14 23.6	12.1	1.45	22		15 1.7		8.49	24		3 55.9	30.0	14.31	13
			11.5		22			11.7		23			30.0		12
26		14 35.7	11.5	1.67	22		14 50.2	12.5	8.72	24		3 25.9	30.1	14.44	12
27		14 47.2	10.8	1.89	22		14 37.5	13.4	8.96	24		2 55.8	30.3	14.56	12
28		14 58.0	10.2	2.11	22		14 24.1	14.2	9.19	23		2 25.5	30.5	14.67	11
29		15 8.2	9.6	2.33	23		14 9.9	15.0	9.42	22		1 55.0	30.5	14.73	11
30	—	15 17.8	2.56	2.56	23	—	13 54.9		9.64	22	—	1 24.7	30.3	14.88	10

# EQUATION.

## TABLE

Of Equation of Time to convert apparent into mean Time for 1810, with the secular Variation.

Argument.—Sun's mean Longitude.

Deg.	Sig. IX.			Secular Variation.		Sig. X.			Secular Variation.		Sig. XI.							
0	-	1	24.7	"	14.88	10	+	11	36.3	17.0	14.89	10	+	14	6.9	"	9.96	22
1		0	54.2	30.5	14.78	9		11	53.3	16.2	14.79	11		13	59.9	7.8	9.74	22
2	-	0	23.7	30.5	15.07	8		12	9.5	15.3	14.68	11		13	52.1	8.5	9.52	22
3	+	0	6.8	30.5	15.15	8		12	24.8	14.5	14.57	11		13	43.6	9.1	9.30	22
4		0	37.2	30.4	15.23	8		12	39.3	14.5	14.46	11		13	34.5	9.6	9.28	22
5		1	7.5	30.3	15.30	7		12	53.1	13.8	14.34	12		13	24.9	9.6	8.86	22
				30.1		6				13.0		13				10.2		23
6		1	37.6	29.9	15.36	5		13	6.1	12.1	14.21	13		13	14.7	10.7	8.63	22
7		2	7.5	29.7	15.41	5		13	18.2	11.2	14.08	13		13	4.0	11.6	8.41	23
8		2	37.2	29.7	15.46	5		13	29.4	10.4	13.94	14		12	52.4	12.0	8.18	23
9		3	6.5	29.5	15.51	5		13	39.8	9.5	13.80	15		12	40.4	12.5	7.66	22
10		3	36.0	29.3	15.55	4		13	49.3	8.7	13.65	15		12	27.9	12.5	7.73	23
				28.9		3				8.7		15				13.0		24
11		4	4.9	28.6	15.58	2		13	58.0	7.9	13.50	15		12	14.9	13.4	7.49	23
12		4	33.5	28.3	15.60	1		14	5.9	7.0	13.35	16		12	1.5	14.0	7.26	23
13		5	1.5	27.8	15.61	1		14	12.9	6.1	13.19	16		11	47.5	14.4	7.03	23
14		5	29.6	27.8	15.62	1		14	19.0	5.2	13.03	16		11	33.1	14.4	6.79	24
15		5	56.9	27.3	15.62	0		14	24.2	5.2	12.86	17		11	18.3	14.8	6.55	24
				26.8		0				4.4		17				15.1		23
16		6	23.7	26.3	15.62	1		14	28.6	3.7	12.69	17		11	3.2	15.6	6.32	23
17		6	50.0	25.9	15.61	1		14	32.3	2.8	12.52	17		10	47.0	16.0	6.09	23
18		7	15.9	25.3	15.59	2		14	35.1	2.0	12.34	18		10	31.6	16.3	5.85	24
19		7	41.0	24.6	15.57	2		14	37.1	1.1	12.16	18		10	15.3	16.7	5.61	24
20		8	5.8	24.6	15.54	3		14	38.2	1.1	11.97	19		9	56.6	16.7	5.37	24
				24.1		4				0.3		19				17.0		24
21		8	29.9	23.4	15.50	5		14	38.5	0.6	11.78	19		9	41.6	17.2	5.13	23
22		8	53.3	22.8	15.45	4		14	37.9	1.3	11.59	19		9	24.4	17.4	4.90	24
23		9	16.1	22.1	15.41	6		14	36.6	2.0	11.40	20		9	7.0	17.7	4.66	24
24		9	38.2	21.5	15.35	6		14	34.6	2.7	11.20	20		8	49.3	17.9	4.42	24
25		9	59.7	20.9	15.29	6		14	37.9	2.7	11.00	20		8	31.4	17.9	4.18	24
				20.9		7				3.6		21				18.1		24
26		10	20.6	20.2	15.22	8		14	28.3	4.4	10.79	20		8	13.3	18.3	3.94	24
27		10	40.8	19.3	15.14	8		14	23.9	5.0	10.59	21		7	55.0	18.5	3.74	25
28		11	0.1	18.5	15.06	8		14	18.9	5.6	10.38	21		7	36.5	18.6	3.45	24
29		11	18.6	17.7	14.98	9		14	13.3	6.4	10.17	21		7	17.9	18.7	3.21	24
30	+	11	36.3		14.89		+	14	6.9		9.96		+	6	59.2		2.97	24

EQUATION, *lunar and solar*, in *Chronology*. See METEMPTOSIS.

EQUATOR, or ÆQUATOR, in *Astronomy and Geography*, a great circle of the sphere, equally distant from the two poles of the world, or having the same poles with those of the world.

Such is the circle D A (*Plate XII. Astron. fig. 109.*) its poles being P and Q. It is called the equator, because when the sun is in it the days and nights are equal; whence also it is called the *equinoctial*; and when drawn on maps and planispheres, the *equinoctial line*, or simply the *line*. Every point of the equator is a quadrant's distance from the poles of the world; whence it follows, that the equator divides the sphere into two hemispheres, in one of which is the northern, and in the other the southern pole.

By the passages or transits of arcs of the equator over the meridian, equal or mean time is estimated; hence we have frequent occasion for the conversion of degrees of the equator into time; and again, for the re-conversion of parts of time into degrees or parts of the equator.

For the performance whereof, we subjoin the following table; wherein are exhibited the arcs of the equator, which pass the meridian in the several hours, minutes, &c. of equated or mean time.

Conversion of the Parts of the Equator into Time, and vice versa.

Deg. of Equat.	Hours.	Min.	Hours.	Deg. of Equat.	Hour.	Deg. of Equat.
Min.	Min.	Sec.	Min.	Min.	Sec.	Min.
Sec.	Sec.	Third	Sec.	Sec.	Third.	Sec.
Third.	Third.	Fourth.	Th. "	Th. "	Fourth.	Th. "
1	0	4	1	15	1	0
2	0	8	2	30	2	0
3	0	12	3	45	3	0
4	0	16	4	60	4	1
5	0	20	5	75	5	1
10	0	40	6	90	6	1
15	1	0	9	135	10	2
30	2	0	12	180	20	5
60	4	0	15	225	30	7
90	6	0	18	270	40	10
180	12	0	24	360	60	15
360	24	0	24	360	60	15

The construction of this table is very easy; for the equator being divided into 360 degrees, and revolving always in 24 hours, any point of it moves through 15° in one hour, and in one minute through the 60th part of 15°, or 15' of a degree, and in one second through 15'' of a degree, &c. and therefore nothing more is necessary besides simple addition, in order to have the number of degrees, minutes, and seconds, which it describes in any given time.

The use of the table is obvious; suppose, *e. gr.* it were required to turn 19° 13' 7'' of the equator into time: against 15 deg. in the first column we have 1' 0' 00''; against 4 deg. we have 16' 0''; against 10 minutes, 40''; against 3 minutes, 12'' 0''; against 5 seconds, we have 0' 20''; and against 2 seconds, 8''; which, added together, give 1<sup>h</sup> 16' 52'' 28'''.

Again, suppose it were required to find how many degrees, minutes, &c. of the equator answer to 2½ hours

25 min. 17 sec. and 9 thirds. Against 21<sup>h</sup> in the fourth column of the table, you have 315; and against 2 hours, 30; against 20', 5'; against 5', 15'; against 10 sec. 2' 30''; against 5 sec. 1' 15'' 0''' ; against 2 sec. 30'' 0''' ; against 6 thirds, 1' 30''' ; and against 3 thirds, 45''' ; which, added together, give 351' 19' 17'' 15''' . See EQUINOCTIAL.

EQUATOR, *elevation or altitude of the*. See ELEVATION of the equator.

EQUATOR of the Sun, or Solar Equator. The sun revolves from east to west on an axis inclined to the ecliptic, and the plane, passing through the centre of the sun perpendicular to this axis, is called the plane of the sun's equator. It cuts the plane of the ecliptic in a straight line, called the line of the nodes of this equator; and the nodes themselves are the points where this line, produced each way, meets the celestial sphere.

To determine the position of the axis of rotation in space, it is necessary to determine the inclination of the solar equator to the ecliptic, and the angle which the line of nodes makes with some fixed line in the plane of the ecliptic, for example, with the line of the equinoxes. This angle is called the longitude of the nodes of the solar equator, and is thus determined: when the position of a spot on the disc of the sun has been observed, and its latitude and longitude determined, the direction of the visual rays drawn to the spot at the moment of observation is known. The longitude of the sun at the same instant is likewise known, its distance from the earth, and its apparent diameter.

The intersection, therefore, of its surface with this ray, is found by a simple geometrical process. Three similar observations of the same spot determine three points upon the surface of the sun, and these three spots are situated on the same circumference of some circle parallel to the solar equator, and the position of a plane is known when it passes through three given points. The plane of this circle described by the spot will, therefore, be known by these observations, by which the position of the solar equator may be determined.

To determine the successive positions of the spots on the surface of the sun, supposed spherical, we may imagine the three rectangular co-ordinates or axes passing through the centre of the sun, and continuing parallel to each other during the whole annual revolution. The first of these axes is perpendicular to the ecliptic, the two others are situated in this plane, one parallel to the line of the equinoxes, the other perpendicular to it. Latitudes and longitudes, reckoned relative to these axes from the centre of the sun, are called heliocentric, and they may evidently be found by trigonometric methods, if we can determine their analogous longitudes and latitudes measured in the same manner from the centre of the earth, and which are called geocentric.

By methods of this kind it has been found that the solar equator is inclined to the ecliptic about 7°. It continues constantly parallel to itself, the points of this equator, as they are raised by the rotatory motion of the sun above the plane of the ecliptic, traverse this plane in a point which, seen from the centre of the sun, was, in 1750, 85'. This was then the heliocentric longitude of the solar equator. Since that time it has undergone no variation except what arises from the motion of the equinoctial points.

EQUATORIAL INSTRUMENT, is an instrument made use of in *Practical Astronomy*. When a simple telescope, mounted on a stand, is elevated to view any heavenly body at the moment of its meridian passage, the observed body appears to pass horizontally across the field of view, but in

## EQUATORIAL.

any other situation to the east or west of the meridian, the apparent passage of any heavenly body through the field of view, is in an oblique direction, and the more so, the greater the declination towards the visible pole, and also the greater the distance from the meridian line. Hence the motion of the simple telescope, which moves in a parallel of altitude, or circle parallel to the horizon, when turned round in a state of elevation on its vertical axis, will never coincide with the motion of a heavenly body, that moves either in the equator, or in a circle parallel to it; unless indeed the observer could stand at one of the poles, in which case the equator would become the horizon, and circles of altitude would be also circles of declination. But no observer can be so circumstanced. He may, however, incline the axis of motion of his telescope, so as to be placed in the meridian, and exactly parallel to the earth's axis, and then, when the field of view is directed to take in any heavenly body, the motion of such inclined axis, or the motion of the telescope round such axis, supposing the axis to be fixed, will attend the said body during the remainder of its path above the horizon: Accordingly we find Christopher Scheiner using a telescope mounted on a polar axis in the year 1620, which time was soon after Galileo had invented the simple dioptric telescope, and though John Muller, or Regiomontanus, had contrived and described his torquet, a kind of portable equatorial, in the year 1544, and also Tycho Brahe had given the name of *equatorie* to some of his instruments about thirty years afterwards, yet the idea of Scheiner's polar axis no doubt suggested to the modern instrument-makers the best principle on which an equatorial instrument, as well as equatorial sector, and equatorial stands, ought to be constructed. Scheiner's contrivance was competent to the following of a star or other heavenly body through its diurnal arc, but had no appendages by which to ascertain the place of the observed body, as to right ascension, declination, distance from the meridian, &c. neither would the telescope be directed to a body invisible to the naked eye for want of such appendages.

Mr. Henry Hindley, an eminent clock-maker at York, was probably the first man who contrived and attached the different adjustable circles as companions to the telescope. Mr. Smeaton, in his paper on the "Graduation of Astronomical Instruments," read before the Royal Society of London, on November 17, 1785, has informed us, that Hindley contrived an instrument of the equatorial kind so early as the year 1741, which was sent up to London to be sold in the year 1748. This instrument had the equatorial plate, quadrant of latitude, and declination semi-circle indented at the circumference, and moved by worm-screws, containing fifteen threads each, all in action together, which screws at the same time measured as micrometer screws, the angular motions, and, as it seems, without other graduations. The telescope was of the refracting kind, and inverted the object viewed. "It staid with me," says Mr. Smeaton, "two years, in which time I shewed it to all my mechanical and philosophical friends, amongst whom was Mr. Short, who afterwards published, in the Philosophical Transactions, an account of a portable observatory, but without claiming any particular merit from the contrivance. However, the model of it differs from Hindley's equatorial only in the following articles: he added an azimuth circle and compass at the bottom; he omitted the endless screws, placing verniers in their stead, and at the top a reflecting telescope instead of a refractor. This instrument of Hindley's being afterwards returned to him unfold, I pointed out the principal deficiencies that I found therein; viz. that in putting the instrument into different positions, the spring-

ing of the materials was such, as in some positions to amount to considerable errors. This remained with him in the same state till the year of the first transit of Venus in 1761, when it was sold to — Constable, esq. of Burton Constable in Holderness. Mr. Hindley, to remedy the evil above-mentioned, applied balances to the different movements. He soon after completed one, *de novo*, upon this improved plan, for his Grace the late duke of Norfolk." The next, in point of time, to Mr. Hindley, was Mr. Short, who placed his reflecting telescope over a system of graduated circles, and who has generally been considered as the first contriver of the equatorial instrument, though it appears evident from Mr. Smeaton's account, that Hindley's instrument was prior to his. Mr. Short published his account in the Transactions of the Royal Society, not in the year 1789, as stated by a typographical error under our article CIRCLE, but in 1749, in vol. xvi. N<sup>o</sup> 493. About the year 1770 a rage for making equatorial instruments generally prevailed, and numberless were the modifications that makers of every description produced, but the chief improvers of the instrument at that period were Nairne, Ramsden, and Dollond, who married Ramsden's sister, all of whom, soon after the year just specified, improved on the original portable instrument, chiefly by introducing the improved dioptric in place of the heavy catoptric telescopes, and by using the best divided circles, together with the most accurate adjustments, balancing of the parts, and nicely divided verniers. Mr. Ramsden, to secure the advantages of his share of the improvements, took out a patent for his instrument, including the refraction apparatus, and hanging level in the year 1775.

Still, however, the equatorial instrument had its scale of magnitude adapted only for portability, and its circles consequently were not capable of measuring with that degree of accuracy that celestial observations demand, to be of real use in the present improved state of astronomy; and it remained for Mr. Edward Troughton to construct an equatorial instrument sufficiently large to be placed in an observatory, for the purpose of making useful observations. This ingenious artist contrived many commodious modifications of the instrument under our present consideration, but we mean to confine our notice to two of the principal of them, both worthy of future imitation; one as a moveable, though not very portable instrument, and the other as a fixed one. The first was made to go to Coimbra, in Portugal, where it has had the ill fate to be shut up in the dark, though it was finished so long ago as the year 1788; the latter is now in use under the direction of Dr. Hamilton, at Armagh, in Ireland, and is that with which the Armagh observations were made; of these Mr. Pond, the lecturer on astronomy at the Royal Institution, availed himself when he composed his famous catalogue of declinations of some of the principal stars, which we noticed under our article CIRCLE, and which is inserted in the article DECLINATION. This instrument was made in the year 1796; about three-years after sir George Shuckburgh's large equatorial instrument was described in the Philosophical Transactions of London, as an instrument on a large scale, carefully made under Mr. Ramsden's direction by Mr. Berge, who has since become his successor. The principal modern authors who have described the different equatorial instruments, are Mr. Short, Mr. Benjamin Martin, Mr. Nairne, Mr. Dollond, the Hon. Stuart M<sup>c</sup>Kenzie, professor Vince, and sir George Shuckburgh; at one time it was our intention to describe one or two only of the different constructions of this instrument, and to have noticed the differences of the others; but to do justice to the subject, and to show more clearly the progressive

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progressive improvements in the art of constructing astronomical instruments of this description, we have determined to give drawings and corresponding descriptions, in succession, of each instrument that appears to possess any claim to originality. Of course we must avail ourselves of the respective descriptions that have been published of the various instruments that have been before described, but our detail will be a condensed one, and interspersed with original remarks, tending to assist the reader in forming his opinion of their respective merits; and where no description has been previously given, as is the case with Mr. Troughton's instruments, and a neat portable one by his nephew, Mr. Farer, we shall supply the accounts from original and authentic sources, preserving, as we proceed, that order of time in which the several instruments were constructed, except in the instance of Mr. Farer's, which being portable, we have thought it better to place immediately after the portable ones of older date, by way of contrast, than to give it a place after the larger and more complete instruments.

*Portable Equatorial Instrument by Mr. James Short.*—We have already said that Mr. Short's equatorial instrument, called by him the equatorial telescope, or portable observatory, was the first instrument probably made in England that could be considered as a well arranged assemblage of graduated circles for ascertaining the various data of a heavenly body's place, out of the meridian, by a single observation. Mr. Ben. Martin has given a brief description of this instrument, together with its uses, in appendix II. of his *Philosophia Britannica*, the substance of which, not being in every one's hands, we think may be acceptable to our readers, particularly as its perusal will afford the best means of contrasting the more improved instruments with the original model, and, consequently, of tracing the progress that the art of making instruments of this kind has made within the period of our own recollection. *Fig. 1. of Plate XI. of Astronomical Instruments*, exhibits a perspective view of all the essential parts of Mr. Short's instrument, which is composed of four graduated circles, two of them entire, and two of them about three-fourths of a circle, together with a four-footed stand, a variety of supporting pillars, levels, wheels, and endless screws, axes of motion, and a reflecting telescope surmounted over the whole. A, A, are two horizontal plates one over the other, and representing the horizon of the place of observation; these plates rest on four pillars of the pedestal, that contains a magnetic box and needle, and that is supported by the four adjustment screws B, B, B, B, the lower plate being fast to the pillars, and the upper one, that carries two spirit levels on its plane at right angles to each other, being moveable by a rod or handle C, the screw on which takes into the teeth cut on the edge of this upper horizontal plate. This moveable plate is divided into  $360^\circ$ , and a vernier borne by the under plate reads to the accuracy of every three minutes. Another set of four pillars, inserted into the moveable horizontal plate, supports the vertical circle D D, or rather portion of a circle, which is divided into twice  $90^\circ$ , and somewhat more at each side, and is called the meridian circle; its vernier, placed on the upper horizontal circle, reads also every three minutes of space. The handle or rod E moves this circle in like manner as the rod C moves the horizontal circle described. On the upper or mutilated part of the meridian circle D D, are placed two other plates, the upper one moveable on the under one, like the horizontal plates, and the vernier carried by the under one. It does not appear from the drawing or account whether the axis of motion rotates or is fixed. The upper or moveable plate, marked F F, is divided into hours and ten-minute spaces, and these again are subdivided

by the vernier into single minutes of time. This plate, which is called the equatorial plate, has a third set of pillars inserted into it, and is moveable by the rod G, like the other moveable plates; the pillars support a fourth circle, or rather mutilated circle H H, on the upper part of which the telescope L L is mounted, as seen in the drawing. This uppermost circle is called the circle of declination or horary circle, and is divided into twice  $90^\circ$ ; it is also moveable by the rod or handle K, like the rest of the moveable circles; and has every three minutes of space, by its vernier, placed on the plane of the equatorial circle. The telescope is of the Gregorian construction, with a great speculum of 18 inches focal length. In making the adjustments of this instrument for observation, the horizontal plates A, A, are first levelled by the joint aid of the two levels and screws of adjustment that bear the whole fabric; this adjustment is not perfect till the bubbles of the levels will remain stationary, in the middle of their tube, while the upper plate is carried quite round the subjacent one. In the next place the meridian circle D D is turned by its handle E, till the equatorial plates are parallel to the equator; that is, till they are raised equal to the complement of the latitude of the place of observation, and the instrument is said to be fit for making observations; of course the placing of the circles relatively to each other, in regard to perpendicularity, and of the line of collimation of the telescope in regard to the points zero in the declination circle, are supposed to be immoveably adjusted by the maker, so as to require no future rectification. As it will be of some importance to the development of the progressive improvements of the different equatorial instruments, to confine ourselves to the uses that this instrument by Mr. Short was applied to, we cannot do better than confine ourselves to the words of one of the early descriptions of its practical application.

*“To find the Hour of the Day, and Meridian of the Place.*—First, find, from astronomical tables, the sun's declination for the day, and for that particular time of the day; then set the declination-semicircle to the declination of the sun, taking particular notice whether it is north or south, and set the declination-semicircle accordingly.

“You then turn about the horizontal handle, and the equatorial handle, both at the same time, till you find the sun precisely concentrical with the field of the telescope. If you have a clock or watch at hand, mark the instant of time; and by looking upon the equatorial plate and vernier, you will find the hour and minute of the day, which comparing with the time shewn by the clock or watch, shews how much either of them differs from the sun. In this manner you find the hour of the day.

“Now, in order to find the meridian of the place, and, consequently, to have a mark by which you may always know your meridian again, you first move the equatorial plate, by means of the equatorial handle, till the meridian of the plate or hour-line of 12 is in the middle of the vernier; and then, by turning about the declination-handle till the telescope comes down to the horizon, you observe the place or point which is then in the middle of the field of the telescope; and a supposed line, drawn from the centre of this field to that point in the horizon, is your meridian line. The best time of the day for making this observation for finding your meridian is about three hours before noon, or as much after noon. The meridian of the place may be found by this method so exact, that it will not differ at any time from the true meridian above  $10''$  of time, and if a proper allowance be made for the refraction at the time of observation, it may be found much more exact. This line

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line thus found will be of use to save trouble afterwards; and is, indeed, the foundation of all astronomical observations.

*To find a Star or Planet in the Day-Time, even at Noon-Day.*—The instrument remaining as rectified in the last experiment, you set the declination-semicircle to the declination of the star or planet you want to see; and then you set the equatorial plate to the right ascension of the star or planet at that time, and, looking through the telescope, you will see the star or planet; and after you have once got it into the field, you cannot lose it: for, as the diurnal motion of a star is parallel to the equator, by your moving the equatorial handle so as to follow it, you will at any time, while it is above the horizon, recover it, if it be gone out of the field.

“The easiest method for seeing a star or planet in the day-time is this; your instrument being adjusted as before directed, you bring the telescope down so as to look directly at your meridian mark; and then you set it to the declination, and right ascension, as before-mentioned.

“By this instrument most of the stars of the first and second magnitude have been seen even at mid-day, and the sun shining bright; as also Mercury, Venus, and Jupiter: Saturn, and Mars are not so easy to be seen, upon account of the faintness of their light, except indeed when the sun is but a few hours above the horizon.

“And in the same manner in the night-time, when you can see a star, planet, or any new phenomenon, such as a comet, you may find its declination and right ascension immediately, by turning about the equatorial handle, and declination handle, till you see the star, planet, or phenomenon; and then looking upon the equatorial plate, you find its right ascension in time; and you find upon the declination-semicircle its declination in degrees and minutes.

“In order to have the other uses of this instrument, you must make the equatorial plates become parallel to the horizontal plates; and then this instrument becomes an equal altitude instrument, a transit instrument, a theodolite, a quadrant, an azimuth instrument, and a level. The manner of applying it to these different purposes is too obvious to need any explanation.

“As there is also a box with a magnetic needle fastened in the lower plate of this instrument, by it you may adjust the instrument nearly in the meridian; and by it likewise you may find the variation of the needle; if you set the horizontal meridian, and the equatorial meridian, in the middle of their verniers, and direct your telescope to your meridian mark, you observe how many degrees from the meridian of the box the needle points at: and this distance or difference is the variation of the needle.”

These are the uses to which Mr. Short's instrument, before us, was principally applied, and had the circles been divided with verniers subdividing the divisions more minutely, it would have been something more than an astronomical play-thing, to which it cannot be considered as any thing superior, when it comes to be contrasted with one of the most improved kind, even of those that are equally portable. We cannot dismiss our notice, however, of the present instrument, without remarking further, that the manner in which the two pairs of plates A A, and F F, move over each other respectively, is by no means calculated to preserve a steady undeviating motion, for want of a sufficient length in the axis of motion. This is the principal objection we expressed to Dr. Wollaston's circle made by Mr. Cary, and if the doctor borrowed his notion of such a position of his circles from Mr. Short, he copied one of the worst properties that this artist's instrument possesses.

This equatorial instrument has obtained the name of

universal, from the circumstance of its being applicable to use in any latitude; which name is equally due to its successions.

*Portable Equatorial Instrument by Mr. Ed. Nairne.*—The imperfections of the preceding instrument were attempted to be removed by Mr. Nairne, whose construction introduced a long axis of motion for the horizontal circle, thereby effecting a steadiness in its performance, and placed the telescope on the axis of the declination-semicircle to obtain a less encumbered elevation of the telescope; but still the circles were not graduated so minutely as to render them of real use in practical astronomy. A brief account of this instrument is contained in vol. lxi. part i. of the Philosophical Transactions of London, and was read before the Society on Feb. 7, 1771. Its substance is this:—

The instrument consists of the following parts, *Plate XII. fig. 1. of Astronomical Instruments*, a mahogany triangular stand A A A, and three adjusting screws B, B, B, a moveable azimuth circle C, which is divided into degrees, and by a vernier index into every six minutes; above this azimuth circle is the horizontal plate D, to the under part of which is fastened the vertical conical axis E; on the middle of the upper surface of the horizontal plate is placed a ground glass level F, by which the plate D is set parallel, and the pillar E perpendicular to the horizon; from this plate rise perpendicularly two quadrants G, G, one of which is divided for the latitude into half degrees, and has a vernier index to three minutes; the equatorial plate H, with its hour circle, is supported by the two quadrants G, G, its axis of motion, which is placed near the hours XII, XII, passes through the centres of the quadrants, and carries the index I, pointing to the divided quadrant; the equatorial plate is divided into half degrees, and has a vernier index shewing every three minutes of right ascension, or 12 seconds of time; it is figured to shew both degrees and time. To prevent misapprehension it may be right to remark that the hours XII, XII, ought properly to have been placed according to the meridian line; but they are here placed otherwise for the convenience of better seeing the meridian distance shewn by the vernier. On the upper part of the equatorial plate is the plate K; upon this plate K are fixed the two supporters M, M, which support the axis N, under which is fastened the semicircle of declination O, divided into half degrees with a vernier subdividing it into every three minutes. On the upper part of this axis is fixed an achromatic telescope P, which magnifies about 50 times; to the eye-end of this telescope is applied a small reflecting speculum, making an angle of 45° with the axis of the telescope, whereby objects that are in the zenith or in any other altitude may be observed without putting the body in an inconvenient position. To the under part of the axis N is fastened a brass arm carrying the weight Q, which counterbalances the telescope, and brass-work annexed to it; whilst the weights R, R, counterbalance in like manner the whole of the instrument that is moveable on the equatorial axis, so that whatever position the instrument is put in it will there remain, being perfectly balanced. The four motions of this instrument may, when required, be moved extremely slowly, by means of the indented edges of the circles and semicircles, and the screws or worms of the handles S, T, V, and W, for the horizontal circle, the motion for latitude, the equatorial and declination motions respectively. The adjustments and uses of this instrument are so similar to those of its predecessor, both in kind and extent, that it would be superfluous to particularize them again. In this account it is not stated whether the axis of motion of the equatorial circle is prolonged,

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longed, but as the height to which it is elevated above the horizon circle seems to admit of it, and as the axis of this is elongated, we are disposed to believe that a similar advantage belonged to the former; otherwise it would not have that stability that is necessary in this part of the instrument for making the most essential motion steady enough to be depended on. How far the mahogany legs were firm and steady enough for the purpose of affording a motionless pedestal is not said; but the want of accuracy, or rather the want of minuteness in the divisions and subdivisions of the graduated circles, quadrant, and semicircle, made this consideration of less importance than it would have been in an instrument possessing greater powers. We have been informed, from credible authority, that Mr. W. Ludlam, of St. John's college, Cambridge, was the principal contriver of Mr. Nairne's construction.

*Ramden's portable equatorial instrument.*—The principal parts of this instrument, says professor Vince, (Treatise on Prac. Astr.) are, the azimuth circle *GH*, the equatorial, or hour circle *EF*, and the declination circle *CD*; (see *Plate XI. fig. 2. of Astronomical Instruments*;) to this latter there is fixed a telescope *AB*, having under it a rod *mn*, passing through two pieces  $\pi$ ,  $\rho$ , in one of which, as  $\pi$ , are two screws acting on the rod against each other, in order to adjust the rod perpendicular to the axis on which the declination circle turns. The azimuth circle *GH* lies on a brass plate *tu*, supported by three feet, resting on the screws *X, Y, Z*, and on this plate it turns about an axis *T*, by means of a screw *S*; upon this circle are placed two spirit levels *c d, a b*, at right angles to each other, supported at each end by a screw, by which they may be adjusted; the circle is divided into twice  $180^\circ$ , and has a vernier *V* fixed on the plate *tu*, by which the degrees are subdivided into minutes or half minutes, according to the size of the instrument; and by means of the screw *I* the circle may be fixed to the plate *tu*. *KK* is a polar axis moveable about a centre *L*, sustained by two supporters  $\eta, i$ , resting on two pieces *W, V*, firmly connected to the plane of the circle *GH*; the lower end of this axis has an arc fixed to it, which runs against an arc  $\alpha\gamma$ , attached to *GH*, and to which it may be fixed by a key at *e*; and in this situation, if you apply the key to *Q*, it gives a motion to the axis, by which you may very accurately adjust the telescope to an object. To the centre *L*, and perpendicular to the polar axis, are fixed two strong pieces of brass, one of which is here represented by  $\kappa$ , and the other is on the other side of the axis; these support a circle  $\alpha\beta\gamma\delta$ ; on the top of the polar axis, and perpendicular to it, is placed a brass plate, moveable about a pivot on the top of the axis; to this are fixed four pieces, two of which are represented by  $f, g$ ; these are connected to the hour circle *EF*, lying on  $\alpha\beta\gamma\delta$ , and carry it about; upon  $\alpha\beta\gamma\delta$ , at *W*, is fixed a vernier to the circle *EF*, which circle is divided into twice twelve hours. The declination circle *CD* is supported by its centre, on an axis resting on two supporters  $h, k$ , on one side, and two others of the like kind on the other; these rest upon the brass piece on the top of the polar axis, and may be adjusted by two pair of screws at the feet of the two supporters, to set the plane of the declination circle perpendicular to the hour circle, which, by the maker, is placed perpendicular to the polar axis. This circle is divided from zero both ways to a little more than  $90^\circ$ , and a vernier is placed at *R* to subdivide, as at *V*. A small quadrant is fixed to the eye-piece of the telescope, which turns round upon the piece, carrying two wires perpendicular to each other, for the parallel of declination and hour circle. The eye-piece carries two cross

wires to represent the circle of altitude and a parallel to the horizon. The quadrant has two radii  $o$ , perpendicular to each other, and move together; the former has a round or circular spirit level upon it, so that by turning about the eye-glass and the quadrant till the bubble rests in the middle, the plane of the quadrant becomes perpendicular to the horizon; and the vernier on the latter shews the altitude to which the telescope is directed, and the corresponding refraction; and in this position the circle of altitude is perpendicular to the horizon. At *P* is a small micrometer circle, called the refraction circle, (with a fixed index,) moveable by a finger screw; this circle is divided into half minutes, and one revolution is equal to  $3' 18''$ ; when moved it raises or depresses the centre of the cross wires in a circle of altitude.

After this general description of the parts of the instrument, let us consider what motions it is capable of, and what the circles may be made to represent, before we proceed to its adjustments. And first, the azimuth circle *GH*, being set parallel to the horizon, will represent the horizon; secondly, if the polar axis *KK* be inclined to the horizon at an angle equal to the latitude of the place, the equatorial circle *EF* will be inclined to the horizon in an angle equal to the inclination of the equator to the horizon; therefore, if we turn about the azimuth circle, and consequently the equatorial circle, the latter may be made to coincide with the equator; thirdly, if the declination circle be set perpendicular to the equatorial, then the consequences must be, that if the line of collimation be adjusted parallel to the plane of the declination circle, or perpendicular to its axis, and also parallel to the equatorial circle *EF*, when zero on the declination circle coincides with zero on the vernier *R*, then the telescope is directed to the equator in the heavens, and by turning about the declination circle the line of collimation will describe a secondary to the equator; and by setting the declination circle to the declination of any body in the heavens, if we turn about the circle *EF*, and consequently the circle *CD* with the telescope, on the brass plate, on the top of the polar axis (which is kept fixed,) the equatorial circle, moving in its own plane perpendicular to the polar axis, must continue to coincide with the equator, and, consequently, the telescope will describe a parallel to the equator, and therefore must bring the body into the field of view. These being the motions of the parts of the instrument, we may now proceed to describe the necessary adjustments for them.

*Adjustments.*—1. *To adjust the azimuth circle parallel to the horizon.*—Turn it till one of its levels becomes parallel to a line joining two of the screws at the feet, as *X, Z*, and then adjust that level with one of them; turn the circle half round, and if the bubble be not in the middle, adjust it half way, by one of the above-mentioned screws, and half way by the screw at one end of the level; repeat this operation till the bubble stands right in both these positions; then turn the circle at right angles to these positions, and, if necessary, set the bubble right by the other screw *Y* at the foot, and the adjustment is made. If you previously adjust the other level by one of the screws at the end, then the circle may be adjusted horizontal by them, without turning it.

2. *To adjust the level  $rs$  parallel to the rod *mn*.*—Set the polar axis, as near as you can, perpendicular to the horizon, and turn about the declination circle *CD* by a pinion for that purpose, until the bubble of the level *rs* stands in the middle; reverse the level, and if the bubble do not stand in the middle, adjust it half way by the screw at *S*, under

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one end of the level, and half way by turning the declination circle; and repeat the operation till the bubble stands in the middle in both positions.

3. *To adjust the rod  $m n$  perpendicular to the axis on which the declination circle turns.*—Set the polar axis as near as you can parallel, and consequently the equatorial circle perpendicular to the horizon; set the declination circle to zero, and turn the hour circle till the bubble stands right; then set the declination circle to  $90^\circ$ , and adjust the bubble by the polar axis: then turn the declination circle to the opposite  $90^\circ$ , and if the level be not right, correct half the error by the polar axis, and the other half by the two screws in the piece  $\alpha$ , releasing one and screwing up the other; repeat this operation till the bubble stands right in both positions, and the adjustment is made. For these two adjustments tend, the former to set the axis of the declination circle, on the axis about which the rod revolves, perpendicular to the horizon: and the other to set the rod  $m n$  parallel to the horizon, and consequently perpendicular to that axis; when, therefore, the bubble thus continues right, both circumstances must have taken place.

4. *To set the axis of the declination circle perpendicular to the polar axis.*—The instrument remaining as in the last adjustment, that is, the declination circle at  $90^\circ$  and the bubble right, turn the equatorial circle half round, and if the bubble be not right, correct half the error by the polar axis, and the other half by the two pair of screws at the feet of the two supporters  $b, k$ ; and repeat this operation till the bubble is right in both positions, and the adjustment is completed. For the former adjustment tends to set the axis of the declination circle perpendicular to the horizon, and the latter to set it parallel to the equatorial circle, or perpendicular to the polar axis; consequently, when the bubble is right in both the above positions both circumstances must take place, that is, the polar axis must be parallel to the horizon, and the axis of the declination circle perpendicular to it. And as this adjustment is made by the level, which is horizontal when the axis of the declination circle is thus adjusted perpendicular to the horizon, and which is previously adjusted parallel to the rod, they must both be perpendicular to the axis, about which they turn; and, consequently, they move in a plane passing through the polar axis, or perpendicular to the equatorial circle. Hence, also, the declination circle, being perpendicular to its own axis, becomes perpendicular to the equatorial circle.

5. *To make the centre of the cross wires cut the same object whilst you turn round the eye-glass by the pinion of the refraction apparatus.*—Set the index on the refraction circle to the beginning of the divisions, and turn round the eye-glass, and if the centre of the wires do not continue to cut the same object, correct it by four small screws (which you will find by unscrewing the nearest end of the eye-tube which contains the first eye-glass), the two opposite at a time, and repeat the correction till the centre continues to cut the same object.

6. *To make the line of collimation describe a great circle perpendicular to the equatorial circle.*—Set the declination circle to  $90^\circ$ , and the equatorial circle to VI, and bring the bubble to the middle by the polar axis. Then note some object covered by the centre of the cross wires, representing the parallel of declination and hour circle, and turn the equatorial circle half round, and if the same object be not now covered by the centre of the wires, move, if necessary, the declination circle in its own plane, until it is in the same vertical circle with the object, and then bring the centre half way to it by the upper and lower of the four small

screws which move these wires, and turn the declination circle back through half the space it was moved, and you get a new object now covered by the centre of the wires; repeat this operation till the same object be covered in both these positions; then set the hour circle to XII, and bring the bubble to the middle by the declination circle, and if the centre do not now cover the same object, bring it to the object by the other two screws, and the line of collimation is adjusted parallel to the level, or to the rod  $m n$ , and, consequently, it must be perpendicular to the axis of the declination circle. Hence as that circle is turned about in its own place, the line of collimation must describe a secondary to the equator. The line of collimation for the centre of the cross wires being thus adjusted, it is, at the same time, in the centre of motion, on which the wires parallel and perpendicular to the horizon turn; hence, when the index of the refraction circle is set to the beginning of the divisions, the interfections of the two sets of wires coincide. The adjustment of the wire parallel to the equatorial circle may be examined by the passage of a star through the telescope, (all the other adjustments being previously made, and the equatorial circle adjusted to coincide with the equator in the heavens, and the declination circle set to the star's declination;) for if the star do not run upon the wire, it must be adjusted till it does: or it may be done thus. Set the equatorial circle to XII, and having directed the line of collimation to some small well defined object, turn the declination circle in its own plane, and observe whether the perpendicular wire continue to cut the same object as it passes through the field of view; if not, adjust till it does.

7. *To adjust the verniers of the equatorial and declination circles.*—Elevate the equatorial circle to an angle of about  $45^\circ$ , as most proper for this purpose, and set the declination circle to zero, and turn the equatorial circle in its own plane till the bubble stands right; then turn the equatorial circle half round, and if the bubble do not stand right, adjust half by moving the equatorial, and half by moving the declination circle; and repeat this operation till the bubble stands right in both positions, then, by moving the verniers, set zero on the vernier belonging to the equatorial circle to VI, and zero on the vernier belonging to the declination circle to zero, and the verniers are adjusted. Thus the instrument is ready for observation, except that the azimuth circle is not adjusted to shew azimuths, which will be done when we come to shew the methods of making observations.

The method here used arises out of the two distinguishing features of the instrument under our consideration; namely, the position of the level near the telescope, and the want of graduations on the latitude arch, or arch for giving the polar axis its due inclination.

But the Hon. Mr. M'Kenzie's method appears to us more simple, as well as more intelligible, for elevating the equatorial circle to the co-latitude of the place, thus; "lower the telescope as many degrees, minutes, and seconds below zero, on the declination-semicircle, as the complement of your latitude is; then elevate the polar axis till the bubble be horizontal, and the equatorial circle will be elevated to the co-latitude of the place, as required; after which the level may be made to stand true in opposite positions, and the verniers be placed to zero, as above directed.

Mr. Atwood, in his Syllabus, has given another method of making this adjustment, which professor Vince acknowledges to have the advantage over his in point of both ease and accuracy, the substance of which is as follows:

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Having set the declination circle to  $90^\circ$  in either quadrant, direct the point of intersection of the cross-wires to coincide with some distant object as a mark; turn the equatorial circle in its own plane  $180^\circ$ , and if the intersection does not now coincide with the distant mark, correct half the error in declination by moving the declination circle in its own plane, and half the error in right ascension by the set screws of the supporters that adjust the axis of the declination circle; now if these adjustments be accurately made, the intersection will coincide with any distant mark, chosen anew, when the equatorial circle has been turned  $180^\circ$ ; but if the coincidence is not perfect, the same adjustments must be repeated till the condition is fulfilled. The line of collimation being now directed to coincide with the distant mark, set the vernier of the declination circle to  $90^\circ$ , and turn this circle  $180^\circ$  in its own plane, turn also the azimuth circle, so that the line of collimation may be again directed to the said distant mark, then turn the equatorial circle about in its own plane  $180^\circ$ , and if the distant mark be not now covered by the intersection, the quantity of deviation shews double the total error of dividing the two semi-circles of the declination circle, and also its eccentricity, which errors cannot be allowed for by adjustment. The error in right ascension, now discovered, must arise from the plane of the declination circle not being quite perpendicular to the equatorial, and also from the line of collimation not being exactly parallel to the plane of the declination circle; therefore correct  $\frac{1}{4}$ th of the error by the screws of the declination axis, and  $\frac{1}{4}$ th by moving the line of collimation perpendicular to the plane of the declination circle: if the first trial of these adjustments be not attended with complete success, when the distant mark is again examined in reversed positions they must be repeated till they are correct. Hence it is manifest, when the above adjustments are properly made, 1st, that the line of collimation is parallel to the plane of the declination circle; 2dly, that the plane of the declination circle is perpendicular to the plane of the equatorial; 3dly, that the errors of division are at the opposite points  $90^\circ$ , if any are discovered in the declination circle, and, 4thly, that when the declination circle is set to  $90^\circ$ , the line of collimation is perpendicular to the plane of the equatorial circle, or, when it is set to zero, it is parallel to it.

The azimuth circle being adjusted horizontal, and the declination circle put to  $90^\circ$ , make the vertical wire parallel to it, turning the equatorial and azimuth circles in their respective planes; direct the point of intersection to a distant mark near the horizon, and move the azimuth and declination circles each in their own planes to  $180^\circ$ , so that the said mark may appear somewhere in the vertical wire, and if there is an error in altitude, let the line of collimation bisect it, by moving the polar axis, and it will then be horizontal. Let this new bisected point or mark in the horizon be noted; then the declination circle being put to zero, turn the azimuth circle  $90^\circ$ , so as to bring the new mark upon the cross wire, and direct the intersection to it by turning the equatorial circle in its own plane, and the declination is in that situation parallel to the horizon. The instrument remaining as before, turn the equatorial and azimuth circles in their respective planes  $180^\circ$ , and if each circle be accurately divided, the telescope must evidently be brought into a position exactly parallel to its former one, and therefore the intersection of the wires will again coincide with the new mark in the horizon. Otherwise the quantity each of those circles must be moved further or back, will shew their respective errors of eccentricity and also of division. Lastly, the declination circle being at zero,

and the line of collimation or intersection made to coincide with the horizontal mark, by moving the equatorial and azimuth circles, set the equatorial vernier to VI, and the adjustment is finished; for the line of collimation being parallel to the horizon and to the plane of the declination circle when the vernier stands at VI, that plane, by revolving about the polar axis, must be perpendicular to the horizon when the vernier stands at XII, which is the thing required.

### *Methods of making Observations.*

1. *To take the altitude of a body above the horizon.*—Set XII on the equatorial circle to zero on its vernier, and the plane of the declination circle is then perpendicular to the horizon; make, therefore, the line of collimation horizontal, by bringing the bubble to the middle of the level in the telescope, and observe what point of the declination circle stands against zero in its vernier, and then by moving the declination and azimuth circles in their own planes, bring the body to the centre of the cross wires, and observe again what point of the declination circle stands against zero, and the arc intercepted between these two points gives the apparent altitude. If the declination circle had been set to zero, and the line of collimation been adjusted horizontal by moving the polar axis, then, when the body had been brought to the centre of the cross wires, the declination circle would have shewn its altitude at once. For Mr. Atwood's indirect methods of taking an altitude, see pages 163, 164, and 165 of Vince's "Treatise on Practical Astronomy."

2. *To measure very small vertical angles.*—Let the elevation of the equatorial circle be  $a$ , the polar distance of the telescope (either more or less than  $90^\circ$ ) be  $b$ , and set XII (corresponding to noon) on the equatorial circle to zero; then if that circle describes an angle whose versed sine is  $v$ , and the line of collimation be brought (by moving the azimuth circle) back to the same vertical, it will have been depressed through a vertical arc equal to  $\frac{v \times \text{si. } a \times \text{si. } b}{\text{si. } b - a}$ , radius being unity. Or, if  $b = 90^\circ$ ,

the depression =  $v \times \tan. a$ . Hence if, for example, it should be required to find the angle which the horizontal wire of the telescope subtends, select some well defined distant object, set the declination circle to zero, and XII on the equatorial to zero, and elevate the equatorial so as to bring the object into the field of view, and make the upper edge of the wire coincide with it, then move the equatorial and azimuth circles in their own planes till the lower edge coincide with it, and read off the equatorial arc. *Ex.* If the elevation of the equatorial be  $41^\circ 3'$ , and the arc denoted by the equatorial vernier be  $57'$ , the angle required =  $\text{vec. sin. } 57' \times \tan. 41^\circ 3' = 24'' 6''$ . Hence also the diameter of a planet may be measured. When the planet comes to the meridian (the two circles being fixed as before) alter the elevation of the equatorial circle, and bring the upper edge of the horizontal wire to be a tangent to the upper limb of the planet (or the apparent lower limb), and then by turning the azimuth and equatorial circles in their own planes, bring the lower edge of the wire to be a tangent to the lower limb of the planet (or the apparent upper limb), and the rule gives the sum of the diameters of the planet and wire, from which subtract the diameter of the wire, and you get the diameter of the planet.

3. *To find the latitude of a place.*—Take the altitude of the sun's upper or lower limb a little before noon, and continue your observation till he rises no longer, and you get

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his apparent meridian altitude; with which and his declination you may find the latitude by the common rule.

4. *To incline the equatorial circle so as to make any angle with the horizon.*—Set the declination-circle (in the southern quadrant) to the given angle, and XII on the equatorial circle to zero on its vernier; then bring the line of collimation horizontal by moving the polar axis till the bubble in the level on the telescope stands in the middle, and the equatorial circle stands at the proper angle.

5. *To determine the position of the meridian.*—Elevate by the last article the equatorial circle, to make an angle with the horizon equal to the co-latitude of the place, and set the declination-circle to the declination of any known star, then turn the equatorial and azimuth-circles in their own planes till the star is brought to the centre of the cross wires, and correct the position of these circles on account of refraction, by the small quadrant and apparatus at the eyepiece of the telescope, and the equatorial circle will then coincide with the equator in the heavens, and the vernier will shew how far, in time, the star is from the meridian; and hence, if we turn the equatorial circle till XII stands at zero on the vernier, the plane of the declination-circle will coincide with the meridian. Hence, if we direct the telescope to the horizon, the point which the centre of the wires will cut is the south point of the horizon, and may serve for a meridian mark. If the point of the arc of the azimuth-circle lying against zero on its vernier be noted, the error in its position will be known; and if this be very small, so that by moving the vernier till zero on it may be brought to zero on the arc, it may be adjusted to shew azimuths. The position of the vernier of the azimuth-circle may also be verified thus. The equatorial-circle being set parallel to the horizon, and XII set to zero on its vernier, turn the azimuth-circle, and by moving the declination-circle, bring a star on the east side of the meridian to the centre of the cross wires, and note the azimuth, then turn the azimuth-circle (the telescope remaining fixed) and do the same when the body comes to the west side; and if the azimuths at both observations be the same, the vernier is adjusted right; if not, half their difference is the error. The instrument being set upon a moveable plane, if the points on which the three screws at the feet rest be marked, it will then always be easy to set the azimuth-circle very nearly in its proper position.

6. *To determine the apparent time of the day.*—Proceed as in the last article, only take the sun instead of a star, and bring its centre to the centre of the cross wires, and correct for refraction, and the arc intercepted between XII and zero on the vernier shews the distance of the sun, in time, from the meridian, or from apparent noon.

7. *To find a star or planet in the day-time.*—Elevate the equatorial-circle to make an angle equal to the co-latitude, and adjust it to coincide with the equator in the heavens, and set the declination-circle to the declination of the body. Find by the usual way the distance of the star from the meridian at the time required, and reduce it to sidereal time; then turn the equatorial-circle in its own plane, east or west, as the star lies, till the arc between XII and zero on the vernier be equal to that time, and the star will be in the field of view. By this means Jupiter, Venus, and fixed stars of the first magnitude, may be observed in the day-time.

8. *To find the right ascension and declination of a star.*—Elevate the equatorial-circle to the co-latitude of the place, and previously set it to coincide with the equator in the heavens, and set XII on the equatorial-circle to zero on its vernier. After this set the declination-circle to the sun's declination, and take the time of its transit; then set the

declination-circle to the star's declination and take the time of its transit, and the difference of the times will give the difference of their right ascensions; and the star's transit being taken at the intersection of the wires, the declination-circle (corrected for refraction) will give its declination. Thus also you may compare two stars, or the moon and a star. Or it may be done at any time, if you move the declination and equatorial-circles in their own planes till the star is brought to the centre of the cross wires, and correct the position of these circles on account of refraction, and the declination-circle will give you the declination required; and the vernier of the equatorial-circle will give you the star's distance, in time, from the meridian, or your clock will give you the sun's distance, the difference of which times gives the difference of their right ascensions, and, therefore, knowing the sun's right ascension, you have the right ascension of the star.

9. *To find the longitude.*—The equatorial-circle being set to coincide with the equator in the heavens, and XII to zero on its vernier, take the time of the transit of the moon's limb, and also of a proper star as near as possible to the moon's parallel, and the longitude may be determined therefrom by the lunar method, in the usual way.

10. *To measure horizontal angles.*—Adjust the equatorial-circle parallel to the azimuth-circle; and having directed the line of collimation to one of the objects, move the equatorial-circle in its own plane, and also the declination-circle, if necessary, and bring the line of collimation to the other, and the arc through which the equatorial-circle has moved gives the angle required.

As an appendage to this account, by professor Vince, of Ramsden's portable equatorial instrument, we think it may be acceptable to our readers to have the Hon. S. M'Kenzie's account of Mr. Ramsden's new refraction apparatus much improved, which was published in his anonymous pamphlet, (dated in the year 1791, a year after the professor's treatise was published), together with the explication of the principles on which the apparatus was constructed.—“Refraction or parallax,” says our author, “by changing the apparent altitude of a planet, may also change its apparent right ascension and declination; see fig. 2. of Plate XII. (of *Astron. Instr.*) where HO represents the horizon; EQ, part of the equator; P, the pole of the equator; Z, the zenith; PEH, the meridian; ZV, an arc of a vertical drawn through I, the apparent place, and F, the true place of the planet; PA, a circle of declination, or hour-circle, drawn through the true place F; and PB, a circle of declination or hour-circle drawn through the apparent place I. The error in altitude from F to I alters the right ascension of the planet as much as the arc of the equator AB, or its parallel FC, amounts to. It also alters its declination from AF to BL, that is, from C to I. If a planet be in the meridian at L, the error, in declination from L to K, will be the same as the error in altitude; but there will be no error in right ascension, because the same circle of declination PEH, (perpendicular to the horizon,) passes through the apparent place K, and the true place L. In like manner, if by the construction of an instrument you have a vertical circle ZV, perpendicular to the horizon, it will pass through the apparent place I and the true place F, and there will be no error in right ascension; and if by the same instrument the error in altitude from F to I be determined, the true place F is found, and consequently there will be no error in declination. With Mr. Ramsden's new refraction apparatus you have just such a vertical circle as will appear from what follows.

In the focus of the telescope of the equatorial two *fixed* wires

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wires are placed at right angles to each other; one, E Q, (see fig. 4.) represents part of a parallel of the equator; the other, P A, part of a meridian, or hour-circle. There are also two moveable cross wires at right angles to each other; one, H O, represents a portion of a parallel to the horizon; the other, Z V, a portion of a vertical circle. These moveable wires have a motion round the axis of the telescope, by turning a pinion.

A small quadrant (see Plate XI. fig. 2. and also Plate XII. fig. 2.) is fixed on the part that carries the moveable wires, with divisions on each side; one expressing the degree of altitude of the object viewed, the other expressing the minutes and seconds of error occasioned by refraction, corresponding to that degree of altitude. To the index of this quadrant is fixed a small circular level, which being adjusted by its own pinion, gives the altitude; while by another pinion it ascertains the perpendicularity of one of the moveable wires, which gives the vertical circle above-mentioned, whereby the true right ascension may be determined, free from all error arising from refraction or parallax. Hence, in taking the moon's right ascension with an equatorial instrument, fitted with this refraction apparatus, in order to determine longitudes at land, there is no occasion to attend to her parallax, as the difference of her right ascension, caused by parallax or refraction, will only depress or elevate her on the same vertical circle, but will not change her right ascension from one hour-circle to another. In this refraction apparatus the centre of the fixed wires always remains in the line of collimation; whereas by the former construction, on raising or depressing that centre, it was moved out of that line; and as it was very difficult to replace it exactly, an error in the observation was liable thereby to be produced. In all observations made with this refraction apparatus, first adjust the circular-level, then set the centre of the moveable wires, by the micrometer screw, to the refraction corresponding to the altitude of the object viewed, as given by the small quadrant; and let one of the moveable wires be set always perpendicular. Since copying the preceding extract from Mr. McKenzie's pamphlet, we have been assured that it was published previously to professor Vince's treatise, and that the date 1791 is a typographical error for 1771; accordingly, we learn from Mr. Dollond, that Ramsden's instrument preceded his, but our inquiries to obtain the *precise time* of its origin have not been successful. The two different sizes of Ramsden's portable instrument were according to the following table of dimensions.

	Rad. in In.	Limb divided to	Vernier of 30 gives	Divided to parts	By vernier into
Azim. or horizontal circle,	5.1	15'	0° 30"	45 <sup>th</sup> of in.	1350 <sup>h</sup>
	2.7	30	1' 0"	42 <sup>d</sup> ditto	1262
Equatorial or hour-circle,	5.1	15 or 1 <sup>m</sup>	30" or 2'	45 <sup>th</sup> ditto	1350
	2.7	30 or 2	1' or 4'	42 <sup>d</sup> ditto	1260
Vertical semi-circle for declination or latitude,	5.5	15'	30"	42 <sup>d</sup> ditto	1260
	2.75	30	1'	41 <sup>th</sup> ditto	1230

*Portable Equatorial Instrument by Messrs. P. and J. Dollond.*  
—Mr. Dollond informs us that his father contrived the instrument, which now comes under our notice, in or about the

year 1775, and the readiness with which he communicated all the particulars we wished for respecting it deserves our grateful acknowledgment. This instrument, says the author, (in his quarto pamphlet,) which of all others is the most amusing to lovers of astronomy, is now rendered, by the following improvements, greatly superior to any hitherto produced. As the whole weight does not exceed thirty pounds, it may be said to be truly portable, yet, by the steadiness of all the parts, and the perfection of the achromatic telescope, the observations may be made to a very great exactness. The focal length of the achromatic object-glass is about 17 inches; it is composed of three glasses, and admits of an aperture of two inches. The tube being made as thin as possible, is easily balanced by the weight A, which is fixed in the semi-circle B B; (see fig. 3. of Plate XI.) then again all the parts above the horizontal axis (the end of which is seen as C) are balanced by the square weight D. By means of these balances the centre of gravity is preserved over the centre of the instrument in every position, and the different parts prevented from being strained when the instrument is put into any oblique position, which may be required in its various uses. This also tends to keep the telescope steady, which is of the greatest advantage in making an observation. Besides these very essential improvements, every part has been reduced to the most simple state; and several, which in other instruments of this kind, were found superfluous, have been entirely rejected.

The instrument is supported by three feet E, E, E; the screws *a, a, a*, are to raise or depress the feet, in order to bring the plate G G into an horizontal position, which is determined by two spirit-levels *b, b*, that are fixed on it at right angles to one another. If these levels are well adjusted, the plate will be horizontal when the air-bubbles come into the middle of the glass tubes. As this plate represents the horizon of the place, it is called the horizontal plate: it is divided into half-degrees, and by a vernier *c* of thirty divisions is subdivided to every minute. This index is made to move round the centre of the horizontal plate in order to set it to zero, or point *o*, when that point is found to be in the plane of the meridian. The plate is moved round by turning the handle *d*. The worm-screw, which works in the part *e*, may be easily disengaged from the plate, when any considerable quantity is required to be moved at once. Press the handle *d* outwards, and the worm will be disengaged. The plate F F is called the equatorial plate, as it represents the plane of the equator; it turns on the horizontal axis C, so that it may be inclined according to the latitude of the place, which is shewn on the latitude arch *f f*, that passes through the square weight D: this arch is divided into 90°, and by the vernier is subdivided into every minute. The tube *g* is fixed to the horizontal axis, close under the centre of the equatorial plate. An axis is fixed to the middle of the plate, which passes through the tube *g*, into a centre fixed in the square weight; this axis tends greatly to secure the equatorial plate from swaying, when put into different inclinations, or when the telescope is turned into any oblique position.

The horizontal axis is made parallel to the horizontal plate by turning the screw *b*, which will raise or depress that end of it. When the equatorial plate is inclined nearly to the latitude of the place, the clamp *i* may be tightened by the screw at the side; then, by turning the finger-screw *k*, it may be adjusted to the greatest exactness: the vernier *l* may be adjusted, (in case any error should be found,) by the small screws at *m*.

The equatorial plate is divided into twice XII hours; these

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these are subdivided into every two minutes of time, and by the vernier *n* again subdivided to every four seconds. This plate is moved round by turning the handle *O*. The worm-screw which works in the edge may be disengaged from the plate, by pressing the handle *O* outwards.

Above this plate is the semi-circle *BB*, which is called the declination semi-circle; this is divided into twice  $90^\circ$ , and subdivided as the other circles are; it is fixed to the axis *H*, which may be made parallel to the horizontal axis by the screw *p*, in the same manner as the horizontal axis is made parallel to the horizontal plate. On this declination semi-circle the telescope *II* is supported, and being balanced by the weight *A*, is moved with the greatest ease, by means of the pinion fixed at *q*, which is turned with the fingers at *r*.

To set the line of collimation of the telescope at right angles to the axis *H*, the wires in the eye-tube *s* may be moved in an horizontal direction by the screws, which will be discovered when the part of the eye-tube *t* is taken off; this piece carries the eye-glasses, and is made to slide on the part that contains the wires, that distinct vision may be obtained by eyes of different convexities. There are four eye-tubes, intended for different purposes, producing magnifying powers from 40 to 60, and an eye-piece with a diagonal speculum is sometimes added for gaining a convenient view of stars near the zenith. There is a combination of lenses to the number of four in one of these eye-tubes; and the enlargement of the field of view thereby affords a pleasing view of the heavens. Besides these, there is a sliding piece containing smoked glasses to guard the eyes of the observer from the sun's rays, which glasses are smoked but faintly at one end, and have the shade of darkness gradually increased towards the other to suit all states of illumination. There is also a semi-ring fitted by friction to the tube of the telescope, near the object end, which bears an arm holding a small diagonal reflector to direct the light of a lamp or candle into the tube so as to enlighten the cross wires contained in one of the eye-tubes.

The compass box, placed on one side of the horizontal plate, is useful in ascertaining nearly the meridian line, and also in detecting the variation of the magnetic needle at any time. These were the original parts composing the instrument before us; and the instrument viewed as a whole piece of mechanism presents a slightly compact figure, but the circumstance of the declination-semicircle, not allowing the telescope to reach as high as the pole, is an objection in the construction of this instrument, which, we are obliged to confess, renders it of less value in our estimation than it otherwise would have been. When the instrument is to be adjusted for observation, the horizontal plate is levelled by the levels in the first place, and then the equatorial plate is made parallel to the equator itself, by moving the square weight along the arc *ff* till the vernier *l* marks the latitude of the place. The directions given for the uses of Mr. Short's instrument will equally apply here as far as they go, but as this instrument professes greater accuracy in the readings than that of Nairne's, its uses are more extensive; for it will serve occasionally for an equal altitude instrument, a transit instrument, a quadrant or sextant, an azimuth circle, a theodolite, and a level.

When this instrument is to be used for observing equal altitudes, bring zero on the equatorial plate to zero on the vernier *z*, by the handle *O*, and zero on the vernier *l* to  $90^\circ$  on the latitude arch, taking care that the clamp *i* is made fast by the screw at the side; adjust the horizontal plate very nicely by the two levels and feet screws, then by turning the handles *d* and *r* bring the telescope to the sun for the morning

observations: in the afternoon set again the horizontal plate level, and the declination-semicircle to the degree and minute shewn at the corresponding morning observation; then bring the telescope to the sun by turning the handle *d* only. In this manner several corresponding altitudes may be observed on the same day, and the instrument used in the mean time for other purposes. For the methods of making equal altitudes serviceable in the practice of nautical astronomy, see problems X, XI, XII, and XIII, in our article CHRONOMETER.

To convert this equatorial into a transit instrument, bring zero on the vernier *l* to  $90^\circ$  on the latitude arch, and fix the clamp *i*; level the horizontal plate, and bring the telescope to the meridian mark, supposed to be ascertained, by turning the handles *d* and *r*: turn now the handle *r* alone, and it will raise the telescope in the plane of the meridian, so that when the sun or stars are seen to pass the vertical wire, they will then be upon the meridian, and the time may be noted accordingly. This application supposes of course the axes of the declination-circle perfectly parallel to the horizon plate, and also the line of collimation perfectly parallel to the same plate, but at right angles to the former, when the vernier is at zero. These verifications, however, we think, demand the levels to be applied nearer to the telescope than on the horizon plate only.

When the instrument is in the position just described, let the moveable vernier *c* be put to zero on the horizontal plate and be made fast, then turn the handles *d* and *r* to bring any celestial object into the field of view of the telescope, and its azimuth will be shewn on the horizontal plate, while at the same time its altitude will be indicated on the declination semi-circle.

When used as a theodolite, let this instrument have its horizontal plate levelled as before; then bring zero on the equatorial plate to zero on the vernier *z*, and also zero on the vernier *l* to  $90^\circ$  on the arc of latitude, and fix the clamp *i*. Turn the horizontal plate and declination-semicircle, so as to gain a view of the object whence the angle is to be measured; then bring the telescope to the second object, by moving the equatorial plate and declination-semicircle without the horizontal plate, and this last plate will then shew the measure of the said angle; and if there is any elevation or depression of the latter object compared with the first, the declination-semicircle will point it out. The bearings, also, will be shewn by the compass, as in the common theodolite.

When zero on the semicircle is brought to zero on the vernier *y*, the instrument then becomes a level; so that by turning the equatorial plate round, an observer may see what objects are level with the telescope. For this purpose also, our opinion is, that the level would be much better applied parallel to the telescope, on the declination-semicircle itself.

The late Mr. John Dollond had invented his object-glass micrometer previously to his arrangement of the circles and other parts of his equatorial instrument, seeing Dr. Maskelyne gave a paper on it to the Royal Society, which was read Dec. 12, 1771, which micrometer was sometimes made an appendage to his equatorial; but as this addition is not peculiar to the instrument in question, but may be applied to any other astronomical instrument, or even a common telescope, we will describe it hereafter, under our article EQUATORIAL Micrometer. We must not, however, omit a notice of the refraction apparatus belonging to the equatorial instrument, as made by the Dollonds, an account of which was read before the Royal Society on March 4, 1779, as drawn up by Mr. Peter Dollond, and presented by  
the

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the astronomer royal. *Fig. 3. of Plate XII. of Astronomical Instruments*, is a representation of this apparatus, detached from the object end of a telescope. The account itself, being short, will admit of being transcribed.

“The refraction of the atmosphere,” says the author, “occasions the stars or planets to appear higher above the horizon than they really are; therefore a correction for this refraction should be made in a vertical direction to the horizon. The equatorial instrument is so constructed, that the correction cannot be made by the arches or circles which compose it, when the star, &c. is in any other vertical arch, except that of the meridian; because the declination arch is never in a vertical position but when the telescope is in the plane of the meridian.

“To correct this error, a method of moving the eye tube, which contains the wires of the telescope in a vertical direction to the horizon, has been practised; but as the eye-tube is obliged to be turned round, in order to move it in that direction in the different oblique positions of the instrument, the wires are thereby put out of their proper situation in every other position of the instrument, except when it is in the plane of the meridian; for the equatorial wire should always be parallel to the equator, that the star in passing over the field of the telescope may move along with it, otherwise we cannot judge whether the telescope be set to the proper declination, except at the instant the star is brought to the intersection of the wires, which is only a momentary observation.

“The method I have now put in practice for correcting the refraction of the atmosphere, is, by applying two lenses before the object-glass of the telescope; one of them convex, and the other concave; both ground on spheres of the same radius, which in those I have made is thirty feet. The convex lens is round, of the same diameter as the object-glass of the telescope, and fixed into a brass frame, or apparatus, which fits on to the end of the telescope. The concave lens is of the same width, but nearly two inches longer than it is wide, and is fixed in an oblong frame, which is made to slide on the frame that the other lens is fixed into, and close to it. These two lenses being wrought on spheres of the same radius, the refraction of the one will be exactly destroyed by that of the other, and the focal length of the object-glass will not be altered by their being applied before it: and if the centres of these two lenses coincide with each other, and also with that of the object-glass, the image of any object formed in the telescope will not be moved or suffer any change in its position. But if one of the lenses be moved on the other, in the direction of a vertical arch, so as to separate its centre from that of the other lens, it will occasion a refraction, and the image will change its altitude in the telescope. The quantity of the refraction will be always in proportion to the motion of the lens, so that by a scale of equal parts applied to the brass frame, the lens may be set to occasion a refraction equal to the refraction of the atmosphere in any altitude. If the concave lens be moved downwards, that is, towards the horizon, its refraction will then be in a contrary direction to that of the atmosphere, and the star will appear in the telescope as if no refraction had taken place.

“There is a small circular spirit level fixed on one side of the apparatus, which serves to set it in such a position, that the centres of the two lenses may be in the plane of a vertical arch. This level is also used for adjusting a small quadrant, which is fixed to it, and divided into degrees, to shew the elevation of the telescope when directed to the star; then the quantity of refraction answering to that altitude may be found by the common tables, and the con-

cave lens set accordingly, by means of the scale at the side, which is divided into half minutes, and, if required, by using a vernier, may be divided into seconds.

“It must be observed, that when a star or planet is but a few degrees above the horizon, the refraction of the atmosphere occasions it to be considerably coloured. The refraction of the lens acting in a contrary direction would exactly correct that colour, if the dissipation of the rays of light were the same in glass as in air, but as it is greater in glass than in air, the colours occasioned by the refraction of the atmosphere will be rather more than corrected by those occasioned by the refraction of the lens. We may conclude this description with the subjoined references to *fig. 3. of Plate XII.* which is a view of this apparatus:

“A A, the circular brass tube which fits on to the end of the telescope.

“B B, the oblong concave lens, in its frame, which slides over the fixed convex lens.

“C, the circular spirit level, which shews when the oblong lens is in a vertical arch.

“D, the quadrant to which the spirit level is fixed, for shewing the angular elevation of the telescope.

“E, the milled head fixed to a pinion, by which the whole apparatus is turned round on the end of the telescope, in order to set the oblong lens in a vertical arch.

“F, another pinion for setting the quadrant to the angular elevation of the telescope. By means of these two pinions the air bubble must be brought to the middle of the level.

“a a, is the scale, with divisions answering to minutes and half minutes of the refraction occasioned by the concave lens.”

The best portable equatorial instrument of the Dollonds; with a 17 inches achromatic telescope, is marked in their catalogue at 84*l.*; and their achromatic object-glass micrometer of the new construction, at 21*l.*

Were we to be guided by a simple comparison of this instrument and its refraction apparatus with Ramsden's, and to infer from thence which of the two was prior in point of time, we should be induced to place this before the other for obvious reasons, deduced from their comparative constructions, particularly the situation of the levels and refraction apparatus, and total elevation of the telescope; but, on minute inquiry, we found that Ramsden's was the first, and we can only account for the preference we are disposed to give it, from the circumstance of his having a patent, that precluded the latter, though his brother-in-law, from adopting his construction. If there is any real comparative advantage in Dollond's, now that his achromatic telescopes are generally made, it is that which arises from the graduation of the latitude quadrant, and the lightness of the whole instrument; Ramsden's weighing 59 pounds, and Dollond's only 30.

*Portable equatorial instrument by Fayer.*—We have already said that Mr. Fayer of White Lion street, Pentonville, has the possession of a large engine for cutting clock wheels, &c. the property of his uncle Troughton, which we have described under our article *Cutting-engine* as originally made by Rehe: this artist, during some of his hours not occupied by his engine, makes mathematical and philosophical instruments, and among others he has lately constructed a portable equatorial instrument for Mr. Lowe of Islington, which, we think, merits a place in our collection, as being not only an original one, but as possessing advantages likely to recommend it to public attention. This portable instrument differs from its predecessors chiefly in these respects; it has no azimuth circle fixed in a permanently horizontal position; it has its equatorial circle divided into degrees and

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and also into time, with two verniers reading at opposite points, one vernier reads to the accuracy of 30" of space, and the other to 2" of time; this circle has a long axis passing through a tube, like Troughton's large Coimbra instrument hereafter described, from which probably this part of the construction was taken; it may, therefore, be placed in a horizontal direction by its axis being placed firmly vertical, in which situation it becomes an azimuth circle; the telescope is fixed on the end of the axis of the declination circle, which idea corresponds with, and may have been borrowed from, Nairne's construction; this position allows any elevation of the telescope that may be required, and keeps the observer's eye at a distance from the other parts of the instrument, but injures the uniformity of the appearance of the instrument as a whole; the levels are applied, one on the common axis of the telescope and declination circle, and the other at right angles thereto, as a chord to the declination circle; and lastly, the declination circle is complete, with opposite verniers reading, like the other opposite verniers, to an accuracy of twenty or thirty seconds, according to the dimensions of the graduated circles, when nicely divided on Troughton's dividing engine. From such construction it is easy to perceive, that this little instrument possesses the advantage of having its telescope reversed as well as its circles with respect to the opposite verniers, which property greatly ensures the accuracy of the adjustments. After these previous remarks it will suffice to give a brief detail of the parts of this instrument as represented in *fig. 4. of Plate XI. of Astronomical Instruments.*

A, A, A, are three adjustment screws for levelling the circular stand to which the feet are fastened; B, B, are a pair of triangular frames fixed firmly to the said circular stand, and supporting the pivots of the horizontal axis, round which the tube C, attached to the axis, moves; at the summit of the more visible triangular frame B is an adjustable or sliding part Y, like that of a transit instrument, by which the telescope may be adjusted into the meridian, when previously placed nearly so by the feet. The graduated circle D, which may be either an equatorial or azimuth circle, accordingly as its axis is inclined or vertical, has a steel axis nicely fitted to revolve in the tube C, in any position of this tube with respect to the horizon; but the double vernier bar is fast to the inferior end of the tube, as may be seen in the figure: the posterior pivot of the horizontal axis, borne by the triangular bars B, B, projects, and has firmly attached to it the quadrantal piece E, partly hidden from sight in our view of the instrument; this quadrantal piece is graduated, and reads by a vernier as minutely as the other circles; it serves to set the equatorial axis parallel to the earth's axis, in which situation it may be clamped fast, as well as in a vertical, or indeed any other position, by a clamping screw out of sight in the present position applying to the quadrantal arch; F F is the declination circle, with its horizontal axis resting on a pair of vertical supports, carried by the upper end of the polar axis, that passes through the tube C, so that, when the telescope, attached to the axis of the declination circle, has any horizontal or rather oblique motion, the circle D moves with it, and indicates the distance moved along the equator, or in a circle parallel to it, when the polar axis is properly adjusted and clamped fast. The double vernier bar is on the posterior plane of the declination circle, and may therefore be viewed after an observation without danger of altering the position of the telescope. The level on the declination axis may be conveniently adjusted by turning the circle D half round, and by making the bubble keep the middle of the tube in both situations, which may be done, partly by the screws A, A, A, and partly by the screws of rectification of the level itself;

and zero of the declination circle may be put to zero on the verniers when the circle D is truly placed in an horizontal position, in which situation also zero of the quadrant E must coincide with zero on its vernier. Under these circumstances the levels will be competent to effect all that is required, and in the best way; and the instrument will possess all the various powers ascribed to a portable equatorial instrument when converted into the other instruments.

*Universal equatorial instrument by Mr. Ed. Troughton.*—The equatorial instruments we have hitherto described are all, properly speaking, portable, and consequently of a size not professing great accuracy in their readings. We now come to an instrument of larger dimensions, and one having its parts so arranged and adjusted, as to entitle it to rank among the first class of instruments employed in modern observatories. It is of the universal kind, and may be called moveable (in opposition to fixed) rather than portable, as it stands seven feet high, and is therefore too bulky to be carried by one man. It was finished in the year 1788 for the late Mr. J. H. Magellan, and sent by him to the university of Coimbra in Portugal, where we have said it has been unfortunately shut up in the dark. *Plate XIV. of Astronomical Instruments,* exhibits a perspective drawing, shewing all the principal parts of this excellent instrument in its equatorial position, which we propose to describe in the order of their ascent from the ground.

It will not be necessary to give any letters of reference to this instrument, as it is presumed the reader, who has made himself acquainted with the component parts of the preceding instruments, cannot be at a loss to accompany us in our description of the present instrument without the aid of alphabetical references. The basis is of mahogany, consisting at the inferior part of a strong tripod, and at the superior of a circular table; these are connected by three pieces diverging from the table downwards, and connected by diagonal crossing bars: this frame work is still further united by three vertical pillars near the centre, one of which is omitted in the drawing, in order to expose to view a more essential part. Immediately above the table, and parallel to it, is a very strong azimuth circle of brass, 24 inches in diameter; this circle, however, is not in contact with the table, but rests on its conical axis, that passes through a collar of brass, attached to the centre of the table, and is supported on its conical point on a stud fast to the centre of the tripod. This length of bearing, like that of Mr. Nairne's descending axis, keeps the azimuth circle steady in the horizontal line both in motion and at rest, which is a circumstance of the utmost importance. The tripod is furnished with three strong feet screws for the adjustment of the azimuth circle into a true horizontal position; and three handles, with each a Hook's joint, are attached respectively to those screws, that the adjustments may be made with the body in an upright position, or nearly so. The apparatus for quick or slow motion is screwed fast to the table, and clamps to the azimuth or horizontal circle. Two opposite verniers, reading to the accuracy of 10", are attached to the edge of the table, but in such a way that they are of ready adjustment to an exact bisection of the circle, in case the wood work of the table and frame should alter its figure by warping in the least degree; otherwise the wooden frame, as a pedestal, would have been objectionable. Upon the plane of the said azimuth plate are erected two vertical supporters of frame work, somewhat resembling the appearance of two chair backs; which supporters consequently have a motion in azimuth whenever the circle is turned round; they are 19 inches apart from each other, and an horizontal axis of this length binds them together at their upper extremities; the

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the posterior supporter has an adjustment apparatus for bringing the axis perfectly horizontal, which apparatus is hidden in the drawing behind the said supporter. At the middle of the horizontal axis called also the axis of latitude, is a cubical part similar to that in the axis of a transit instrument; to this the long brass socket or tube, that embraces the polar steel axis, is made fast, and is set exactly at right angles thereto by construction. The polar axis, that passes down through this socket, has the equatorial or hour circle attached firmly to it, at right angles also by construction, at its inferior end; and to its superior end above the axis of latitude, is fixed a small platform, of the shape of a parallelogram, to support the superstructure not yet described. Any additional weight may be fixed to the lower end of the polar axis, that the superincumbent materials may require to form an exact equipoise in any position; the sidereal time, depending on the horary angles, is read by opposite verniers, fixed to the inferior end of the long polar socket; one of which only can be seen in the figure of the instrument, as it stands in the drawing: the equatorial circle is divided, so that a single second of time is distinctly read by the verniers; and if the application of three verniers had been thought of when this instrument was constructed, the inequality of the divisions would have been corrected thereby still more perfectly, as well as the excentricity of the circle, if any exists; which observation will equally apply to the azimuth and declination circles. Two quadrants are made fast to the pivots of the axis of latitude, or horizontal axis already described, having their position just within the vertical supporters of the said axis, and consequently move with it, when it has any motion: these quadrants are divided, one of them agreeably to the usual divisions of the circle, and the other by particular desire into 96 equal parts with its subdivisions, and the two verniers are respectively placed on the contiguous supporters of the axis; the use of the quadrants is to fix the elevation or inclination of the polar axis agreeably to the latitude of the place of observation; that is, parallel to the axis of the earth; which position requires to be well verified when the instrument is used. Between the feet of the supporters, and at right angles to each other, are placed, on the plane of the azimuth circle, two nicely ground spirit levels, one of which is about half visible, and the other still less, which serve to place this circle perfectly horizontal in every direction, by the aid of the feet screws: and near the centre of the same circle may be seen an apparatus for adjusting and fixing the polar axis in any given degree of inclination from a horizontal to a vertical position, which it does with equal convenience, accuracy, and steadiness: the lower end of this apparatus may be screwed to any pair of the parallel holes made in the plate, farther from, or nearer to, the centre, as the quantity of inclination may require; while the upper end is attached to a broad ring embracing the socket of the polar axis; and about the middle is an adjustment screw, just above a Hook's joint, that allows the screw to act freely in any position of this apparatus. The ring that embraces the long socket of the polar axis will slide along it till the stem of the said apparatus, into which the screw acts, stands at right angles to the polar axis, in which situation its position will be firm and steady, as the axis can have no lateral or vibratory motion, by reason of its union with the axis of latitude. From this description of the apparatus in question it is easy to perceive that the nearer the polar axis approaches to a vertical situation, the farther from the centre of the azimuth plate must the fixing screws be inserted, and *vice versa*; also the lower towards the equatorial

circle must the sliding ring be, that embraces the socket; as well as the steadier the axis so fixed. Again, upon the platform on the superior end of the polar axis, already noticed, are erected a second pair of supporters, at the distance of 15 inches from each other at the bottom, and, bound together at the same distance at top by the axis of the declination, which consequently is 15 inches long; these supporters, which partake of any motion given to the equatorial circle, bear the declination or meridian circle, and telescope surmounted over all. At the upper end of one of these last named supporters is an adjustment for setting the declination axis at right angles to the polar axis, which is a very essential adjustment; the apparatus for producing quick or slow motion is fast to the platform, the milled nuts of which apparatus may be seen under the declination circle; also the opposite verniers for reading off the angles of declination are attached to the said platform, and both faces of the circle are divided, like the quadrants, one according to common usage, and the other into 384 divisions with their subdivisions, which, at the time of the construction, were considered by Mr. Magellan as the best check on the accuracy of the verniers that read off to 10". The elevated situation of the telescope, which is  $3\frac{1}{2}$  feet long, is sufficiently explained by the drawing, where some of the supporters are seen attached to the declination axis, and some to the circle itself; this elevation was given, that the eye-tube might keep clear of the supporters and other parts of the mechanism, when a star or planet is followed along the equator, or other circle parallel thereto; and as the declination circle is complete, the telescope will rise to any degree of elevation that may be required, while the circle will measure that elevation. As a tangent to the upper edge of the circle, and parallel to the line of collimation of the telescope, is a very sensible spirit level with proper adjustment screws; and on the upper side of the tube of the telescope are mounted two microscopes, the use of which is to observe the coincidence of a fine plumb-line with points made on the tube, when placed in a vertical position for the purpose of levelling the declination axis; and indeed many of the adjustments of this instrument may be verified both by the plumb-line and levels. There are various eye-pieces to answer different purposes, both with and without diagonal reflectors for high altitudes, which it is not necessary to describe here minutely, as they form no distinguishing feature of the instrument. Lastly, the refraction apparatus placed at the eye end of the telescope, as made by Ramsden, was an appendage of this instrument, and by moving the adjustable cross wire in the focus of the eye glass a quantity equal to the refraction or refraction and parallax taken together, rendered the calculations from the tables unnecessary, by converting mechanically the apparent into the true altitude of any observed body. The reading of the subdivisions of a circle by means of a microscopic micrometer had not been adopted at the period this beautiful and useful instrument was constructed, otherwise its powers would have been made more extensive than they now are by the verniers alone.

It is hardly necessary to add, that the powers of this universal instrument, as far as they go, may be readily and conveniently applied to almost all the purposes of practical astronomy, as well as of land-surveying and levelling; seeing it has all the properties ascribed to the preceding instruments, but in a degree approaching nearer to perfection. This is the only instrument of the construction here described that ever was made on so large a scale, but three or four others of an inferior size have since been made on the

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same plan; that, as portable instruments, can hardly be surpassed unless by the adoption of triple verniers, which are of recent origin.

*Adjustments.*—1. In the first place, the telescope must have its wire-plate turned round into such a position, that the middle vertical wire will coincide with a distant mark throughout the whole field of view, as the telescope is elevated or depressed, and then the object-glass must be slid in or out, till a star of the second magnitude is seen as distinctly as possible; to prevent parallax at the wires.

2. In the next place, make the azimuth circle horizontal by means of two levels, adjusting one half of the error, produced by turning the circle half round, by means of the feet-screws, and the other half by the levels, as with the preceding instruments.

3. Make the polar axis perpendicular; clamp it nearly so, and turn the declination circle round till the bubble stands in the middle of its level, now turn the upper part half round on the polar axis, and, if there is an error, correct one-half of it by the apparatus acting on the polar axis, at the azimuth plate, and the other half by turning round the declination axis by the slow motion. When the error has disappeared by a repetition of this process, turn the declination circle round the polar axis just six hours, and bring the bubble to the middle by the adjustment at the top of one of the supporters of the latitude axis: when this is done the azimuth and equatorial circles will be parallel to each other, and their axes perpendicular to the horizon; and, of course, the level near the telescope will keep its bubble at the middle, as well as the other levels, while either or both of these circles revolve. Here the verniers of the latitude-quadrants may be set to their respective zeros.

4. The declination axis must be set level, or at right angles to the polar axis. In order to do this, set the telescope perpendicular by fixing the declination circle with its vernier at  $90^\circ$ , and put on the plumb-line; by the motion of one of the points, which is adjustable, and also by the proper motion of the plumb-line; make the latter bisect both the points under the microscopes; reverse now the telescope by turning the declination circle to the opposite  $90^\circ$ , suspend the plumb-line from the contrary end of the telescope, and by the proper motion of the line make it bisect the fixed point; then half the error that appears at the adjustable point must be corrected by that adjustment, and the other half by that at the top of the supporter of the declination axis.

5. The line of collimation of the telescope must next be adjusted, both as it regards the right ascension and declination. In order to do this, let the upper end of the polar axis, and the object-end of the telescope, be pointed to some fixed object a little above the horizon, the declination circle being first put with  $90^\circ$  to the zero of its vernier, the hour index placed at XII, and the telescope above the polar axis; bring now the centre of the cross-wires to the object fixed on, by raising or lowering the polar axis in conjunction with a motion in azimuth, and read off the degrees, minutes, and seconds shewn by the verniers of the azimuth circle and quadrants respectively; in the next place, set the polar axis nearly vertical, and place the hour circle at the opposite XII, and point the polar axis, as before, to the said fixed object, the telescope being now below it; move the instrument as before, by a compound motion of the polar axis and azimuth circle till the intersection of the middle wires coincides with the object before fixed on and used, and read off, as before; the degrees, minutes, and seconds both on the azimuth circle and quadrants: in this

situation of things, set the azimuth circle to the mean of the two observed azimuths by taking half their sum, and also the polar axis to the mean of the two observed altitudes or inclinations of the polar axis; in this position of the instrument, let the telescope be carefully moved by altering the screws that fasten it to the circle, until the vertical central wire coincides with the original object, and the adjustment for right ascension is finished. Again, move the telescope, by altering it in declination, till the horizontal wire cuts the same object, and adjust the verniers of the declination-circle to the points  $90^\circ$  and  $96$  parts respectively on its opposite planes. If, however, the object is not a very distant one, the above directed adjustment in declination will not be quite correct, because the telescope stands higher, when above the pole than it is below; consequently, when this adjustment is made by means of a near object, two marks should be used on that object, the distance between which must be double the measure from the centre of the declination axis, to the line of collimation of the telescope; otherwise a small angle will be formed at the object, by the two lines of sight, which angle will be subtended by the double distance in question; but when the object is at an infinite distance this small subtense is reduced in effect to nothing, and the same mark therefore will do in both the positions of the telescope.

6. To adjust the hour index let the point  $90^\circ$  of the azimuth circle be turned to an object of small altitude; let the polar axis be made horizontal; and the telescope be set to  $0^\circ$  of declination: in this position the hour circle becomes vertical, and the altitude of the object may be taken by it, which must be read off in time from VI hours: turn now the instrument half round in azimuth, and make the telescope look towards the object by turning round the polar axis; take another altitude in this position, and read off what is indicated from the opposite VI hours, and the mean of these two altitudes is the exact place where the adjustable index must have its zero placed to be in its true position.

The apparatus for correcting the horary angle on account of refraction consists of a small quadrant and level for taking altitudes, which are moveable round the axis of vision, and therefore determine very readily the elevation of the telescope in any given position; also the eye-piece and wires of the telescope being moveable by means of a nice micrometer screw, may be set with great accuracy to the refraction corresponding to the altitude of the observed body as determined by the small quadrant and level.

The chief advantages resulting from the construction of the equatorial instrument just described, are, first, that it affords a firm support to a very long, and, therefore, powerful telescope; and, secondly, that the great range of polar distance beyond  $90^\circ$  of declination renders an observation with the telescope below the polar axis unnecessary.

As the rules we gave for using Ramsden's portable instrument, as extracted from professor Vince's treatise, are not exemplified by actual observations, and as rules, however plain, are not always understood without the illustration of appropriate examples, we cannot finish our account of the present instrument better than by subjoining to the rules given by the Hon. Mr. M<sup>c</sup>Kenzie his examples given at full length, when adapted to our purpose, by which the reader will be led to have an idea of the practical application of the observations to the various purposes of astronomy. The rules were originally written as directions for the use of Ramsden's instrument, but after our account of the adjustments,

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ments, they are equally applicable to the instrument under our immediate consideration.

*Observation 1. To find the latitude of the place by the sun, or any known fixed star.*—The instrument being perfectly adjusted in all its parts according to the directions given,—

Make the polar axis perpendicular to the horizon, and when the sun approaches his meridian altitude, elevate the telescope to that altitude, and adjust the refraction apparatus as above directed: then follow the sun by moving both the equatorial and declination circles (if necessary), and keeping the refraction piece always adjusted till he is at his greatest altitude; the vernier of the declination circle will then give you his meridian altitude; from which subtract his declination, if it be north, or add it if it be south, the remainder if north, and the sum if south, is the height of the equator, that is, the complement of your latitude, which being subtracted from 90°, gives your latitude.

### Example.

Sun's declination supposed	- 6° 57' 37" North.
Meridian altitude of his centre observed	45 6 29
Subtract his declination	- 6 57 37
	38 8 52
Height of the equator or co-latitude	38 8 52
Which subtracted from	- 90 0 0
	51 51 8
Gives your latitude	51 51 8

If instead of observing the altitude of the centre, you observe that of the upper or lower limb of the sun, you must allow for the semi-diameter of the sun, which allowance you find in the Nautical Almanac. Also, if the refraction apparatus were not used, the tables for refraction and parallax in altitude must be used to reduce the apparent to the true altitude.

*Observation 2. To find the meridian by one observation only.*—Elevate the equatorial (or hour) circle to the co-latitude of the place, set the declination circle to the sun's declination for the day and hour required; and adjust the refraction apparatus, then move the azimuth and hour circles both at the same time (either in the same or a contrary direction) till you bring the centre of the moveable wires (the vertical being truly perpendicular) exactly to cover the apparent centre of the sun; that done, the centre of the fixed wires will be in the true centre of the sun, the index of the hour circle will then give the apparent or solar time at the instant of observation. Thus you get the time though the sun be at a distance from the meridian. Then turn the hour circle till the index points precisely at 12 o'clock, and lower the telescope to the horizon to observe some mark in the centre of the telescope, and that is your meridian found by one observation only.

The best time for finding the meridian is, when the sun is three hours distant from the meridian on either side of it.

Observe, that when you have once a true meridian fixed, you need make no use of the refraction apparatus in any observation, except to set one of the moveable wires perpendicular.

The meridian and solar time may be found in like manner by a fixed star, whose declination and right ascension are known.

*Observation 3. To observe a star or planet in broad daylight, at any time when it is above the horizon.*—The table of right ascensions, declinations, &c. of Dr. Maskelyne's 36 principal fixed stars, under the articles CHRONOMETER and DECLINATION, gives you the times of their transits over the meridian in sidereal time.

Elevate the equatorial circle to the co-latitude of the place, and set the vernier of the declination-circle to the star's declination, then adjust the refraction piece; look into the table for the time of its meridian transit or right ascension; then take the time of the said transit from the time of your observation as given by the sidereal clock, borrowing 24 hours if necessary; this difference is the hour to which you must set the hour index of the equatorial circle, and the star will then appear in the telescope.

*Example 1.*—Let it be required to place the telescope of the equatorial instrument to observe Capella on Sept. 30th 1809, exactly at 9<sup>h</sup> 0<sup>m</sup> 0<sup>s</sup> by a sidereal clock well regulated?

Declin. of Capella from Tab. III. under	
CHRONOMETER, 1806	45° 47' 5."88 North.
3¼ years of annual variation add from	
ditto	0 0 17.14
	45 47 23.02 North.
Right ascension or sidereal time of	
transit from ditto, 1806	5 <sup>h</sup> 2 <sup>m</sup> 22."62
3¼ years annual variation add	0 0 16.55
	5 2 39.17
True time of transit	5 2 39.17
Which subtract from sidereal time of	
observation	- 9 0 00.00
	3 57 20.83
And there remains the interval since the	
transit for the index to be put to	3 57 20.83

Note, if the clock shews solar time, it must be converted into sidereal time by problem VI. under our article CHRONOMETER, and then the work may be done as here directed.

*Example 2.*—Let it be required to find Arcturus on April 1st, 1810, when the sidereal time is 10<sup>h</sup> 30<sup>m</sup>?

Declin. of Arcturus 1806	- 20° 11' 59."41 North.
4¼ years annual variation subtract	0 1 19.85
	20 10 39.56 North.
Right ascension or sidereal time of	
transit	- 14 <sup>h</sup> 6 <sup>m</sup> 48."83
4¼ years annual variation add	0 0 11.59
	14 7 0.42
True time of transit	14 7 0.42
Which take from the time of observa-	
tion, borrowing 24 <sup>h</sup>	- 34 30 0.00
	20 22 59.58
The remainder is the place of the index	20 22 59.58

In this observation Mr. McKenzie used a table of meridian passages given in solar time, which required the acceleration of sidereal or solar time to be used; but as the principal catalogues give the passages in sidereal time, we have adapted his rule thereto.

*Observation 4. To find the right ascension and declination of a planet, comet, or fixed star.*—The equatorial circle being elevated, as before, to the complement of the latitude of the place, move the declination and equatorial circles till the planet or comet is in, or near the centre of the field of the telescope, then adjust the refraction piece, and bring the centre of the moveable wires to cover the planet, the vernier of the declination circle will then give you the declination of the planet, and the vernier of the

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equatorial circle will give you the hour of the planet, &c.; then your regulator or clock will give you the sun's time or hour of the day. Take the difference between the sun's time and the planet's time; and if the planet's time be less than the sun's time, add that difference to the sun's right ascension at the time of observation, (which you find in the Nautical Almanac,) the sum (rejecting 24 hours, if it exceeds that number) is the right ascension of the planet, &c. Again, if the planet's time exceeds the sun's time, subtract the difference from the sun's right ascension; the remainder (adding 24 hours to the sun's right ascension, if necessary,) is the right ascension of the planet, &c.

### Example 1.

Observed a star whose time by the equatorial circle is	2 <sup>h</sup> 18 <sup>m</sup> 3' P.M.
Sun's time as given by the regulator, viz.	9 44 40 P.M.
Difference between the two	7 26 37
As the star's time is less than the sun's, add that difference to the sun's right ascension	20 57 9
Reject 24 hours from	28 23 46
Right ascension of the star is	4 23 46

Its declination (by the vernier of the declination circle) is 16° 2' 50" north.

### Example 2.

Observed a star whose time by the equatorial circle is 10 <sup>h</sup> A.M. (that is, astronomically)	22 <sup>h</sup> 0 <sup>m</sup> 0 <sup>s</sup>
Sun's time as given by the regulator, viz. 5° 55' 4" A.M. (that is, astronomically)	17 55 4
Difference between the two	4 4 56
As the star's time exceeds the sun's, subtract that difference from the sun's right ascension	10 38 58
Remains the right ascension of the star	6 34 2

Its declination (by the vernier of the declination circle) is 16° 25' 1" south.

### Observation 4. To find the longitude at land by the right ascension of the moon.

Observed the centre of the moon on the moveable wire set vertical, either in or out of the meridian; time given by the equatorial or hour circle, suppose	2 <sup>h</sup> 28' 2"
Sun's apparent time by the regulator	6 0 0
Difference between those times	3 31 58
Add that difference to the sun's right ascension at 6 hours (because the moon's time is less than the sun's time, for had it been greater, the difference must have been subtracted)	8 25 27

And you have the moon's right ascension at the place of observation at 6 hours	11 57 25
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*Another method of making the above observation.*—The centre of the moon being observed in the same manner at six hours P.M. as before directed, let the instrument remain in the same position it was in (only altering the declination) till a known star comes to the vertical wire, which will happen (suppose) in one hour after, viz. at 7 hours, then subtract that one hour of difference in time of transits, with the addition of 9" 86<sup>4</sup> for the acceleration corresponding to one hour, that is, subtract 1<sup>h</sup> 0' 9" 86<sup>4</sup> from the AR of the star, supposed to be 12<sup>h</sup> 57' 35", the remainder is the moon's AR at six hours P.M. at the place of observation.

Star's right ascension	12 <sup>h</sup> 57' 35"
Difference in sidereal time, (see CHRONOMETER, Tab. I.)	1 0 9.86

Moon's right ascension at 6 hours P.M. at the place of observation.	11 57 25.14
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Then find, by the Nautical Almanac, at what time at Greenwich the moon has the same right ascension as that now observed.

Moon's right ascension at Greenwich at noon is	11 <sup>h</sup> 43' 20"
Ditto at midnight	12 10 36

Difference in those 12 hours	0 27 16
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Moon's right ascension at Greenwich at noon 11 <sup>h</sup> 43' 20"	
Moon's right ascension at 6 hours, at the place of observation	11 57 25

Difference between them	0 14 5
-------------------------	--------

### Proportion for finding the time at Greenwich.

$$\text{As } 27^m 16^s : 14^m 5^s :: 12^h : 6^h 12^m 0^s$$

So that the time at Greenwich, when the moon has 11<sup>h</sup> 57' 25" of right ascension, is 6<sup>h</sup> 12<sup>m</sup> 0<sup>s</sup>, that is, 12<sup>m</sup> later than at the place of observation, which is therefore 12<sup>m</sup> of longitude west from Greenwich.

*Sir George Shuckburgh's fixed equatorial instrument.*—A B, C D, E F, G H, (Plate XV. of *Astronomical Instruments*,) are four columns, says Sir George Shuckburgh, composed of hollow brass tubes 3½ inches in diameter, and five feet ten inches long; these, with two others, one of which appears in part at I K, and the other partially hidden behind E F, are firmly fixed, at their upper ends, to a circle of bell metal B D F H, and, at their lower end, to an inverted truncated hollow cone, L L L, of brass, in height two feet, and in diameter, at the base A G, one foot nine inches. The cross pieces, or tubes P, P, as likewise O, O, and O, O, serve to connect the columns more strongly together, and prevent their bending. These several parts constitute the principal axis of the instrument, the lower end of which terminates in a steel point or cone, resting in a hollow conoid of bell metal, in such manner that the apex of the former does not reach to the bottom of the latter, but the place of bearing, or of friction, is (it may be) about two-tenths of an inch from the extremity of the cone; the other end of this axis finishes in a cylindrical pivot N, of about 1¼ inch long, and one inch in diameter, turning in a Y of bell metal. The entire length of this axis is eight feet four inches, the lower end being supported by an iron frame 3, 4, 5, 6, 7, 8, which is firmly fixed below the floor, into brick-work, and by means of two iron bars, one of which is seen at 28, and the other on the opposite side, not visible in the drawing, is kept

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kept secure from any motion, eastward or westward; the lower part of this frame, to about one foot high, is inclosed by a mahogany box or case 9, 10, the top of which is entirely covered up, and serves as a die or base to this end of the instrument. The other extremity of this long axis, *viz.* the pivot N, rests upon the strong iron support 29, 30, 31, standing 10 feet above the floor, made of massive pieces of cast iron,  $2\frac{1}{2}$  inches wide, and  $\frac{1}{2}$  an inch thick, and held firmly by bolts and nuts as in the figure: 32, and 33, are the places where two iron bars, nearly at right angles to each other, and at  $\frac{1}{2}$  right angles to the meridian, are screwed, to connect this upright support with the walls of the building, and going through the bricks, are held fast by iron collars and nuts on the outside of the wall; these bars, or braces, not in the figure, resist any tendency from the weight or pressure of the instrument, to push the supporter 29, 30, and 31, out of its upright position; and being at right angles to each other, serve to keep it steady with respect to any lateral force that may accidentally be applied. The lower part is continued below the floor, and firmly fixed with mortar and lead into the brick work of an arch. The bottom is shut up in a box or plinth of mahogany, 34, 35, as has been mentioned in the description of the frame supporting the other end of the axis at 9, 10. Near the lower end of the principal axis L N, are inserted 10 concentric brass cones, or radii, *a a, b b, c c, d d, e e*, carrying on their extremities a graduated brass circle, of  $49\frac{1}{2}$  inches diameter, at right angles to the principal axis already described; this circle has two sets of divisions, one of points, and one of lines, each into degrees, and every ten minutes, and the intermediate minutes and seconds are read off by the microscopes W and X, with a moveable wire, and micrometer screw, such as has been described in general Roy's account of his instrument for measuring horizontal angles. (See Philosophical Transactions, vol. lxxx. p. 145.) The circle just mentioned, is inclosed by a circular frame, or rail of mahogany, 14, 15, which is supported by ten balusters, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, (17 and 24 being concealed) and serves to protect the brass circle from any accidental injury in passing by it, without depriving it of exposure to the general temperature of the room. It at the same time affords means of support to a small lamp, 13, which, by reflection from the perforated speculum at the bottom of the microscopes, to be seen in that marked X, throws light upon the divisions by night: 26, 26, and 27, are iron rods that, by being attached to the wooden case, 9, 10, give steadiness to the upright balusters, and the circular frame that they support: 1 and 2 are large stout brass cones firmly fixed into the frame, 3, 4, 5, 6, 7, 8, before mentioned, and whose use is to carry the microscopes W, X. Any degree of pliancy or flexure in these cones would be readily discernible in the microscopes, and extremely detrimental to the observations; they are therefore made as stiff as possible: 3 is a plane forming the upper side of the frame, 3, 4, 5, 6, &c. and consisting of three plates, two moveable in grooves; and one fixed, furnished with suitable screws, one giving the extremity of the axis a motion upward or downward, and the other a motion to the right or left. This latter is procured by a rod passing through the cone 2, one end screwing into the plate below L, near the centre, and the other turned by an occasional handle fixed on, near X, the former motion, *viz.* of elevating or depressing the axis, is procured by a handle fixed on to a screw near: Q R is another circle of the same dimensions with the former, graduated in the same manner, and held together by eight conical radii, *f f, g g, h h, i i*, firmly screwed to a circular centre-piece, which serves as a base to a large conical axis, two

feet three inches long, one side of which is seen at U, and its exterior extremity near V, with its sliding plate and screws for adjustment. Close behind the graduated circle, and at right angles to this axis passing through it, lies the telescope T S,  $5\frac{1}{2}$  feet long. This circle is likewise furnished with two microscopes and micrometers, as in the equatorial circle, one of which is seen at full length at Y, and Z, the eye-tube being at Y, and the object-glass, with the perforated speculum, to throw light at Z; the other microscope, on the opposite side of the circle, is not so prominent in the drawing, being somewhat fore-shortened at Z. Near T,  $\alpha, \alpha, \alpha, \alpha, \alpha, \alpha$ , is an hexagonal lozenge, composed of six brass rulers, firmly fixed to the columns A, B, and E, F, and supporting the lower end of the microscopes, as the pieces  $\beta \beta, \beta \beta$ , in like manner sustain the upper end. By these means, the wire in the field of the microscopes becomes a fixed immoveable index, and after proper adjustment, an exact diameter of the circle, whilst the telescope, together with the circle, turns round the conical axis before-mentioned. At P is a spirit level, passing through the centre plate of the conical axis at right angles to the telescope, supported by a cock at each end, one of which appears at *h*; this cock is placed on the cone U; and by means of a small-toothed wheel and pinion, the level is made to revolve round its own axis, so that the same side of the level may readily be brought uppermost, whatever position the circle be put into; it is also furnished with all necessary adjusting screws. It will readily be seen, that a telescope thus fitted up, will have all the properties of a transit instrument, while the graduated circle will possess those of a meridian quadrant. For this purpose *l m* is a stout brass tube, inclosing a stiff iron rod, turning upon two fine steel points, adjusted by proper screws, parallel to the line of sight of the telescope: this rod is attached to a spirit level of great sensibility, lying below it, which, with the rod, turns round upon the steel points just mentioned, and is in fact a hanging level of the best construction. At the eye-end of the telescope S is a peculiar apparatus, to correct the effects of refraction and parallax, when an observation is made out of the meridian: it is composed of two levels, a small quadrant of altitude *n o*, and a semicircle divided with its vernier to every  $5'$  on the breech plate of the telescope, the exterior eye-tube having a circular motion by a wheel and pinion at *o*, independent of the tube that carries the cross wires; by this means the angle of the horary and vertical circles may at any time be found, together with the altitude of the object, and then by the resolution of two right-angled triangles the refraction and parallax in right ascension and declination will be obtained: *t, u*, are two handles to a Hook's joint at  $\alpha \alpha$ , which turning an endless screw at *w w*, give a gradual motion to the telescope in right ascension or declination; and this motion can at any time be restrained by a clamp at *q*: 11, 12, (the latter not seen,) are two supporters to the clamp and endless screw. The handles *t, u*, are hung on to any part of the instrument by means of the line and wire *v, v*, and are thus kept within the observer's reach. Near *r* and *s* are two microscopes, placed on opposite sides of the circle Q R, and at right angles to the line of sight of the telescope, but are hidden by the columns in our figure; they are of use only when the plumb-line, suspended from the roof of the observatory, is used in preference to the level *l m* above described, either for adjusting the instrument, or observing a meridian altitude, in which case the line must bisect the centres of both microscopes: *y*, and *z*, are thin perforated brass plates, attached to the cover that goes on the object-glass, and by occasionally turning them over it, change the aperture to  $\frac{1}{2}$  or  $\frac{1}{4}$ . The cross wires, of which there are three.

three vertical and one horizontal, within the eye-tube S, have all the requisite adjustments by screws, &c. as in a common transit instrument, and are enlightened at night by a lamp fixed near to one end of the declination axis U, viz. that opposite the end V; but this part of the apparatus is hidden behind the axis and the telescope, except the weight *i*, which is a counterpoise. This lamp throws a light through the conical axis, which is perforated at that end on purpose, on a speculum in the centre of the telescope, placed at  $\frac{1}{2}$  right angles to the axis of the object-glass, and from thence reflected to the cross-wires. This speculum, which is an elliptical diaphragm, is perforated to permit all the rays from the object-glass to pass unobstructed to the eye. The contrivance has been mentioned by Mr. Vince (*Practical Astronomy*, p. 80.) From what has been already described, it must now be evident that if the principal, or polar axis, as it has been called, L N, be elevated to the latitude, and adjusted to the meridian of the place, if the line of sight of the telescope be at right angles to the axis V U, and this latter at right angles to the polar axis L N, the brass circle 14 and 15 will correspond with the equator in the heavens, and the circle Q R will become an horary circle; that is, if the centre of the wires in the field of the telescope be directed to any celestial object, on Q R will be had its declination, and on 14 and 15 its distance from the meridian, from whence, by knowing the hour, the right ascension will be obtained, and consequently its true place in the heavens.

Besides the preceding parts of this expensive instrument, there are some necessary appendages, as a stool marked 36, and some others described in the original account, with references to the accompanying plates, a minute detail of all which would lengthen this article too much; we will therefore briefly enumerate them, and refer the more curious reader to the Transactions themselves for the particulars. The appendages are, 1st, a lamp to illuminate the cross-wires; 2dly, the refraction-piece hereafter described; 3dly, the plumb-line; 4thly, the moveable roof of the observatory; 5thly, a regulator or sidereal clock which indicates degrees, minutes, and seconds of space on the equator; and, 6thly, the meridian mark, consisting of a small adjustable light-house, placed on a brick pier at the distance of 2970 feet, which can be seen as well by night as day.

After a very rigorous examination of the two divided circles of this instrument, it seems that the greatest error, including both the inequalities of the divisions and the eccentricity, never amounts to more than 2" in either of them, and the author calculates that an observation of right ascension, taken out of the meridian, may be depended on to the accuracy of 5", allowing an error of 2" for counting the beat of the clock, 1" for the deviation of the meridian mark, and  $\frac{2}{3}$ " for the error in reading the microscope; but that the error in polar distance may amount to 7", including all the errors of the instrument, of the adjustments, and of the readings. This instrument, it will have been observed, has no azimuth circle, like most of the portable instruments, but if its axis were fixed perfectly vertical, its equatorial circle would then become an azimuth circle, and the instrument altogether would greatly resemble Piazzi's great circular instrument made by Ramsden. From what we apprehend also from sir George Shuckburgh's account of the variableness of the errors of adjustment, in different degrees of temperature, we are disposed to attribute much of the imperfection of this instrument, in this respect, to the metallic support of the upper pivot of the polar axis, which support must naturally elongate and contract its dimensions alternately, by changes of temperature; and as it is composed of various parts differently placed, it affords no data

for ascertaining by calculation either the quantity or direction of deviation from the truth. Before we proceed to the adjustments of this instrument, it may be proper to describe the refraction apparatus which is attached to it, and which is necessary to be understood in using the appended tables. Fig. 2. of Plate XI. exhibits a perspective view of this apparatus on a larger scale than is exhibited in fig. 1. where "A B is a portion of the telescope; C the eye-tube; *a b c* a divided semicircle, *d* its vernier fixed to A B, shewing the angle of the horary and vertical circles; *e* a small spirit-level, attached to the plate on which this semicircle is engraved, and moving with it by means of the screw *f*, which turns a pinion, that works in a toothed wheel, that turns the whole plate, together with the exterior eye-tube round its centre, but without moving the tube that carries the cross-wires. From hence it may be understood, that by turning the screw *f* till the level *e* stands true, the index *d*, which represents a point in the horary circle, will mark how much the division zero, which represents the vertical, is inclined thereto. *l k* is a small quadrant of altitude, that, by means of the level *g*, and screw and pinion *b*, turning on a centre at *m*, gives the elevation above the horizon of any object in the field of the telescope: *i* is a small aperture through which a key is fixed on, to give a lateral motion to the wires to adjust them; and near *f* is another screw, to adjust them parallel to the equator and declination-circle."

This apparatus, it will be seen, has not the refraction-circle, or micrometer and divided nut, to elevate or depress the horizontal wire, a quantity corresponding to the data thereby determined, in order to convert the apparent to the true place of a heavenly body; it therefore indispensably requires the aid of such tables as we have subjoined to our present article; but Ramsden's portable instrument described by the Hon. S. M<sup>r</sup> Kenzie, and by professor Vince, whose accounts we have adopted, has the addition of the micrometer seen in miniature at P, in the figure of that instrument. To that instrument, therefore, as well as to Dollond's, the tables are otherwise unnecessary, than as they serve as a check on the accuracy of the mechanical contrivances in question.

*Adjustments.*—The three principal adjustments, according to sir George Shuckburgh's account, are, 1st, to adjust the level P *k* parallel to the declination axis U V; 2dly, to adjust this axis at right angles to the line of collimation of the telescope; and, 3dly, to make this axis at right angles to the polar axis. The polar axis is placed nearly in the meridian, by means of a meridian mark previously verified, and elevated pretty nearly to the latitude of the plate. This is to be done more accurately afterwards, by the sliding plates and screws at the bottom of the polar axis. The axis of the declination-circle is then brought nearly horizontal, by its proper level, viz. is turned round about the polar axis, till the bubble of the level stands true between the indexes; the instrument is then turned half round about the polar axis, = 180°, shewn by the microscope W. If the bubble then stand true it requires no correction, but if it do not, correct half the error, by moving the equatorial circle by its handle *t*, and the other half by the (invisible) capstan screw, which we will call *a*, or end-screw; then turn the instrument back again to its first position, and see if the level stands true; if not, repeat this operation till it does, correcting one half of the error by the equatorial handle, and the other half by the screw *a*. The declination-axis will then be parallel to the level, and both of them to the horizon. It must be remarked that in this operation it will be necessary to move the declination-circle round its own axis a little, in order to bring the same side of the level up-

permost;

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permost; but this in no degree affects the result, for the imaginary line, round which this axis revolves, is what is meant all along by the axis, and is the line to which the parallelism of the level is referred.

The declination axis remaining in an horizontal position, with the level above the axis, as in the *fig.* turn the declination-circle  $180^\circ$ , *viz.* till the level become below the axis; then, by means of the pinion for this purpose, restore the tube of the level to an upright position, and see if the bubble stand true; if not, correct  $\frac{1}{2}$  the error by the side screw, and the other  $\frac{1}{2}$  by *a*, the end screw. Now turn the declination-circle  $90^\circ$  each way from its last situation, and repeat the examination of the bubble, and correct as before,  $\frac{1}{2}$  by the side screw, at the opposite end of the tube, at right angles to the other side screw; and  $\frac{1}{2}$  by the end screw, near the side screw in question; and if after all these corrections in every part of an entire revolution of the declination-circle round its axis, and of the level round its axis, the bubble stand true, it follows that the axis of the declination-circle, and of the level, are in every direction parallel to each other, both of them to the tangent of curvature, in the middle of the level, and all three to the horizon. This adjustment is therefore complete.

It remains to be seen whether the line of sight of the telescope be at right angles to the declination-axis, and the latter to the polar axis.

Take the error of the collimation of the telescope in right ascension, by a star in the equator, *viz.* let the transit of a star on the equator over the assumed meridian be observed with the declination-circle turned towards the east, and also towards the west. If there be any difference in these observations, it will denote double the error of collimation in right ascension, and half of it will be the deviation of the line of sight from a line at right angles, to the axis of the declination-circle, and is correspondent to a similar adjustment of a transit instrument. The amount of this error being thus ascertained, let it be corrected by the screws, at the eye-end of the telescope, that move the wires to the east and west. The declination-axis, by means of its level being restored to an horizontal position, let the centre wire of the telescope, (by which is always understood the line of collimation,) be brought to bisect the meridian mark, by means of the sliding plate, and adjusting screw, below the polar axis; the telescope will then become a complete transit instrument; for, by the first operation, the declination axis is made parallel to the level and its axis, and both to the horizon; by the second, the line of sight is put at right angles to this axis; and, thirdly, it is adjusted to the meridian.

Now, let the error of collimation in right ascension in the same manner be observed with any star out of the equator, by a circumpolar star, (the nearer the pole the better,) suppose the pole star. If any difference in minutes and seconds of a great circle, as ascertained by the micrometer, should be noticed in its passage with the circle east or west, halve that difference, and it will be equal to the angle that the plane of the declination circle makes with the polar axis, if the observed star were actually in the pole; if not, divide it by the sine of its declination, and the true angle of the plane of this circle, (or of the line of collimation,) with the polar axis will be had. Again, if this operation be repeated with any other stars, and the error so found be divided by the sine of their declination, the error of the plane of the declination circle at the pole, *viz.* its greatest error, or angle with the polar axis, will be had. And note, if these observations are made with stars on each side of the equator, these quantities will be had in opposite directions. Finally, the same may be done by two land objects, one to the north,

and the other to the south, the north and south meridian marks, for instance, proper consideration being had to their declination; by this means the error will be thrown in contrary senses or doubled, and from a variety of such results a very correct mean quantity may ultimately be deduced; and when found must be corrected by the screws at one end of the declination axis.

It has now been seen, that, 1st, the level and its axis are parallel to the axis of the declination circle: 2dly, the line of sight is at right angles to this axis, and parallel to the polar axis; and, consequently, the declination axis is at right angles to the polar axis: 3dly, the polar axis parallel to that of the earth. These are the chief requisites in the adjustment of this instrument. Those that remain are secondary, and we shall take them in the following order: 1st, the adjustment of the cross wires to the focus of the telescope: 2dly, the hanging level: 3dly, the line of collimation north and south, as well as eastward and westward: 4thly, the index wires in the microscopes: 5thly, the refraction apparatus: and, 6thly, the power and scale of the microscopes.

First, *the cross wires.* Let the eye-tube be adjusted to distinct vision for parallel rays by some distant object, such as Jupiter, Saturn, or Venus, by day-light; that done, observe, while one limb of either of these planets appears running along the equatorial wire, whether any motion of the eye, upwards or downwards before the eye-glass, alters the relative place of the image and the wire; if a motion of the eye upwards moves the planet in the *same* direction; the wires are too near the eye-glass, and must be pushed in; and *vice versa*, till the image becomes fixed upon the wire, whatever be the motion of the eye. When this point is obtained, the eye stop, with its wires, must then be fixed, for that is their true place, *viz.* the correct focal point of the object-glass; and whatever indistinctness may be found from the diversity of eyes of different observers, must be corrected by the motion of the eye-glass only. Another point to be secured is the permanency, as far as may be, in the position of the object-glass; for if this be not correctly centered, which is very rarely the case, and, indeed, never to be expected, that is, if its axis be not concentric with the axis of the cell, in which it is fixed, any motion of this latter, by screwing or unscrewing it, may not only change the place of the focus to which the wires are adjusted, but will necessarily move the line of collimation both in right ascension and declination. To obviate this, therefore, two corresponding marks should be made with a graver, both upon the cell into which the glass is burnished, and also upon the tube of the telescope into which the cell is screwed, or otherwise inserted, that in case the object-glass should ever be taken out to clean it, &c. it may be restored very nearly, if not exactly, to its former position.

The eye-glass, object-glass, and wires being thus settled in their respective places to each other, it will not be an improper time to measure the interval between the wires, which cannot be too accurately done, being of such constant use; this may be either, 1st, by observing the passage of a star in the equator, and making proper allowances for the rate of the clock, or by a star out of the equator, and making proper allowances for the declination in the proportion of the radius to the cosine, or, 2dly, by means of the equatorial circle, and a fixed land object; and here the quantity must be diminished in the same ratio as the radius to the sine of the polar distance. We have made use of both methods as a confirmation of each other, and find the interval, which is equal in the three wires of my telescope, to be  $7' 34''.5 = 30''.3$  sidereal time; and these  
three

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three wires divide the diameter of the field very nearly into four equal parts.

Second and third adjustments: *the hanging level.* By means of its proper handle *u*, move the declination circle about its axis, till the bubble of the hanging level *l m* rests true between the indexes; there fix it by the clamp *w*, reverse the level by taking it out of its pivots, and turning it end for end; if the bubble now stand true, the level is adjusted; if not, correct  $\frac{1}{2}$  the error by the declination handle, and the other  $\frac{1}{2}$  by the small screw at the bottom of the level; then reverse the level and repeat this operation till it does. The level, or rather a tangent to its curvature at its middle, will be parallel to the axis on which it swings, and both will be horizontal. At this time look through the telescope, and see what land object is covered by the horizontal wire; now invert the telescope by turning it  $180^\circ$  round the declination axis, and  $180^\circ$  round the polar, and bringing the level true, it will then point to nearly the same place; and if exactly the same object as before be now covered by the horizontal wire, the axis of the level is adjusted parallel to the line of collimation in a vertical direction, if not, correct half the error by the little capstan screw at the bottom of the cock, or arm, that supports one end of the axis of the level, and the other half by the declination handle; invert the telescope, and repeat the operation, till the same object is covered in both positions, and the level is found true, then will the level and its axis be parallel to the line of collimation, and the object covered by the wire may be concluded to be in the horizon.

Fourth. *The index wires of the microscopes.*—The line of collimation, with respect to east and west, has been already adjusted as above. Let then the declination axis, by its level, be restored to an horizontal position; at this time adjust the index wires in the two equatorial microscopes *W, X*, to bisect the two opposite divisions  $360^\circ$  and  $180^\circ$ , then will these wires be rectified to their proper place. That being done, bring  $90^\circ$ , or the division that represents the equator on the declination circle, under its respective microscope, and turn the whole instrument one quarter round on the polar axis, *viz.* till  $90^\circ$  on the equatorial circle be bisected by the micrometer; and, if at this time the bubble of the hanging level appear true, the index wire of the declination microscope is correct; if not, correct  $\frac{1}{2}$  the error by the declination handle *u*, and  $\frac{1}{2}$  by the little screws at the side of the hanging level, then reverse the telescope, *viz.* turn it till  $270^\circ$  on the equatorial circle come under the micrometer wire, and if the level then rest true the adjustment is complete; if not, repeat the operation, as before, till it does; then by its proper screw bring the index wire of the declination micrometers to bisect the points  $90^\circ$  and  $90^\circ$ . The indexes of both circles will be then adjusted, and the axis of the hanging level brought parallel to the line of collimation, with respect to east and west, as well as with respect to north or south. Note, this parallelism of the axis of the level, to the line of collimation in a direction east and west, does not appear to be a very important rectification, but on some occasions may have its use.

Fifth. *The refraction piece.*—After what has been done, this apparatus will be adjusted. Bring the telescope, by means of its two levels *P k*, and *l m*, to point to the horizon, and in the meridian; then by the two points, *f, b*, Plate XI. fig. 2, of the refraction piece, bring its two levels *e* and *g* to rest true; move the nonius *d*, of the little semicircle of the horary and vertical angles, *a, b, c*, to the middle of the divisions, or  $0^\circ$ ,  $0'$ , and also that of the little quadrant of altitude, *l k*, to  $0^\circ$ ,  $0'$ , and this part is adjusted.

Sixth. *The microscopes.*—The magnifying power and scale of the microscopes is all that remains to be considered. The magnifying power of a compound microscope, as is well known, depends on the proportion between the distance of the object, and of its image from the object-glass, together with the proportion between the focus of the eye-glass and the ordinary focus of the eye looking at a small object (suppose) of  $\frac{1}{10}$ th or  $\frac{1}{15}$ th inch. These two ratios compounded give the power of the microscope. The former is called magnifying by distance, and is a material part in the construction of these microscopes; the scale of the micrometer being regulated by this part of the magnifying power. For example, let the distance of the object from the glass be = 1, and the distance of its image = 4, its power will be 4; and consequently the scale of the micrometer or motion of its screw, to answer to  $10'$ , (suppose) must be 4 times as great as the space occupied by  $10'$ , on the limb of the circle; and if the radius of the circle be two feet, an arc of  $10'$  will be equal to 0.07 inch nearly on the limb, and = 0.28 inch on the scale, *viz.* = to the same arc on a circle of 8 feet radius: and if each revolution of the micrometer screw be intended to describe  $1'$ , the screw must contain about 35 threads in an inch. But as it would be difficult to adjust the screw exactly to the scale, the advantage of the construction of these micrometers is, the scale may at any time be adjusted to the screw; for let the interval between any two nearest divisions =  $10'$  on the limb, be measured by the screw, and, suppose, instead of being =  $10'$  or  $600''$ , it appears only =  $570''$ ; it is evident that the scale is bigger than it should be, or, which is the same thing, that the image is less by  $\frac{30}{600}$  or  $\frac{1}{20}$ . In this case, increase the distance between the micrometer wires and the object-glass =  $\frac{1}{20}$ , by unscrewing or drawing out the tube that carries the micrometer and eye-glasses, and the scale is adjusted. It will, at the same time, however, be right to readjust the object-glass of the microscope to distinct vision, by the screw of the cell that contains it, until the image and the wires have no relative change of place by any motion of the eye. This will again occasion some small alteration in the scale, and must be corrected by repeated trials, and the scale adapted to the divisions on the arc; and if the moveable wire of the microscope be now brought to coincide exactly with the fixed one, and the moveable index brought to zero on the screw-head, the micrometer is completely adjusted. This having been done with all the microscopes, and the opposite ones being made to agree, each with the other, in such manner, that the fixed wires may become a correct diameter, the whole instrument will have been completely adjusted.

Before taking an observation of right ascension and declination, the telescope must be adjusted to the meridian mark, so as that the centre wire may exactly bisect it, in which situation care must be taken to make the index wires of the equatorial micrometers bisect the points of  $360^\circ$  and  $180^\circ$ , by means of the adjusting screw of the polar axis; and when an observation is made out of the meridian the altitude and angle of the horary and vertical circles must be taken by the refraction apparatus; then with these arguments, the refraction and parallax, in north polar distance, and in right ascension, may be found by inspection in the subjoined tables, by which any observation may be readily reduced to the meridian.

In this account of sir George Shuckburgh, the reader may have observed, that the order of the adjustments proposed is not that which is best in practice; as some of the leading adjustments must necessarily be deranged by the subsequent ones as he has described them, and indeed so as to

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tender new adjustments necessary; but we were unwilling to transform the baronet's directions that have met with the approbation of the Royal Society, though we cannot dismiss the account without this remark for the reader's consideration; *viz.* the rectification of the telescope, levels, &c. ought certainly to precede the adjustments of the circles, that depend on their accuracy of position.

*The Armagh equatorial instrument by Mr. Ed. Troughton.*—The instrument which now claims our attention is represented in *Plate XVI. of Astronomical Instruments*, and, though similar to its predecessor shewn in *Plate XV.*, as to its use and properties, yet forms a striking contrast with it, in regard to compactness and beauty; too evident a contrast indeed to be overlooked at the first glance of comparative inspection. The arrangement of its principal parts is so novel, and at the same time so natural, as well as the connection of its smaller ones effected with such symmetrical precision, that the mind is struck with the contemplation of it, and spontaneously considers it as an instrument of a superior order, that seems to place at a distance every other individual of its kindred: we therefore feel a peculiar pleasure in concluding our article with the account of an instrument, which, though it comes last, ought in our estimation to stand first, as a model for future imitation. As the different component parts of the equatorial instrument are now become familiar to the reader, who has perused the preceding descriptions, we shall satisfy ourselves with a brief detail, unaccompanied by alphabetical references to the drawing, which presents a perspective view of all the leading features.

The horary or equatorial circle, without centre or radii, occupies the middle part of the instrument; and is held in its proper place by eight conical tubes of brass, four above and four below, which converge respectively towards the upper and lower poles, and which stand at the distance of a quadrant from each other. A strong and light frame is thus formed of the shape of two similar cones joining their bases at the horary circle, and connected near their summits by two pieces of metal that terminate each with a hollow cylinder of about two inches diameter; this frame is further braced by cross connecting tubes, as well as by side braces, or props, in the manner sufficiently explained by the figure; and the whole frame, thus firmly united, supplies the place of a revolving axis, and carries the horary circle round with it, when it is made to turn on its cylindrical pivots. On these pivots the horary circle was finally turned true, after the frame was united and made fast in all its parts, so that the eccentricity of the circle, if it had any previously, was done away, by being turned on its own pivots. The inferior end of the polar axis or frame is supported by a solid stone, about 30 inches above the floor, with which it has no connection to produce unsteadiness; this stone is capped by an apparatus of strong brass work, in which is produced the adjustment for bringing the instrument into the plane of the meridian, as well as that for giving the polar axis its proper elevation. This lower end of the axis terminates in a hemispherical button of hardened and finely polished steel, which presses endwise against a plane of agate, and is kept central by two rollers that form an angle to receive it on the lower part of the apparatus; all which contrivances may be readily conceived without more minute description. The support for the elevated pole consists principally of a stone pier, reaching from the ground to the centre of the instrument; but on it is firmly fixed a strong frame of wrought iron, so constructed as to turn its edges towards the telescope hereafter described, in every direction; otherwise it would obstruct

the field of view in elevations below the upper pole. The upper gudgeon is received between two rollers similar to those below, except that these are perforated, as well as the gudgeons, in order that as little light as possible may be intercepted when the telescope is pointed to the pole. At about six feet distance from each other, in the east and west line, upon the same solid foundation that supports the bearing stone and pier, are firmly fixed two pillars of stone, each nearly three feet high; and on the tops of these are placed fast two strong cones of brass to support the microscopes for reading off the horary angles. The length of these two cones of brass is so proportioned as to correspond to the effective length of one half of the frame, or polar axis, in its inclined state, in all changes of temperature, by which means the microscopes preserve their relative situations at the horary circle. This circle is divided into 5' spaces, or spaces of 20 seconds of time, upon its extreme or exterior edge, which was made broad for this purpose, and the heads of the equatorial micrometers are so divided as to subdivide the said spaces into tenths of a second of time. The axes of the microscopes of course are horizontal. At the tops of the conical parts of the pillars are adjustments for moving the microscopes; one with respect to perpendicular height, another with respect to the distance of the exterior edges of the horary circle, and a third along its plane. An apparatus also for quick or slow motion is attached to each of the cones in question, by means of which the instrument may be securely fixed, either in the meridian, or in any other given position, as it regards the meridian. The declination circle likewise occupies the middle of the frame, and has its centre precisely in the same point that is the centre also of the horary circle, these two circles being concentric, but having their planes exactly at right angles to each other, after the manner of the meridian and equatorial circles of a common ring-dial, when put into a state for use. The declination circle is double, or composed of two complete circles united in several places by connecting pillars, and having each eight radii also connected in the same manner, after being inserted into the common axis, which is of the shape of a double cone. The telescope passes through the bases of the united cones of the axis, and has an aperture of  $2\frac{2}{3}$  inches, consequently the connecting pillars are long enough to admit such a telescope between the united circles, in which situation it is not very easily distinguishable in the figure. Its eye-piece, however, is discernible just under the declination circle. It is 44 inches long, and revolves within the horary circle; consequently requires a diagonal or reflecting eye-piece when directed to the equator, in which situation the aperture admits light enough, notwithstanding the interposition of the horary circle. When the elevation is great, the head of the observer must necessarily be admitted between two out of the four lower conical pillars of the frame, which circumstance points out the scale of magnitude on which an instrument of this construction ought to be made, to be useful at all degrees of elevation of the telescope. The telescope has various magnifying powers, which may be used according to circumstances. Two opposite quadrantal arcs of the horary circle have chord-bars parallel to each other, at the middle points of both which are sockets for the gudgeons of the declination axis to work in as their supports; which bearings made the braces of the frame and horary circle essentially necessary to give strength and firmness to the whole. The declination axis, which is about three feet long, has an adjustment at one end for setting it at right angles to the polar axis, and carries also a very sensible spirit-level parallel to itself; with another of which

the telescope is likewise furnished, which it cannot be necessary to particularize further, after our former descriptions of spirit-levels, except that in those the adjustment screws had divided heads, whereas in these there are divided scales of ivory, by means of which the half differences can be accurately estimated to the *fraction of a second*. The declination circle is divided into spaces of 5', which are again subdivided by the microscopic micrometers into minutes and single seconds. One of these microscopes is seen above the horary circle and the other below, but both are supported by it, and point horizontally to opposite points of the declination circle, as one of the others is seen at the top of one of the pillars pointing to the exterior edge of the horary circle. The apparatus for quick or slow motion, to govern the declination circle, is attached to the lower part of the frame, or polar axis, as represented in the figure. The excellence of this instrument has been fully established in public estimation, by the use that has been made by Mr. Pond of the Armagh observations, taken with it in 1797, when he formed his catalogue of some of the principal stars, as we have already stated; in which catalogue (see our article DECLINATION,) it will be seen that the accuracy of its measures accord very nearly with the results derived from an average of the best modern instruments: and we may add, that the coincidence would doubtless have been still more remarkable, had not the divisions, which are by dots, been injured by an accident. An intense frost, to which the instrument was exposed at the top of the maker's house, covered it with black spots, and corroded its surface so as almost to obliterate the dividing points, which were necessarily enlarged by hand, and of course might be altered a little by this manual operation, however carefully performed. The divisions of the other circle met also with an accident at the other side of the water, which, though of a different nature, has rendered the divisions less correct than they were at first. Besides which, two other circumstances ought also to be named as drawbacks in this instrument, when compared with the circular instruments with which it has been contrasted, namely, its verifications were not made with a plumb-line; and its polar position may be considered as somewhat unfavourable for taking declinations with the utmost nicety; but notwithstanding all these deductions, the accurate performance of the instrument has stood the test of a rigid comparison with the instruments of three modern observatories.

*Adjustments.*—1. Turn the *wire-plate* round, if necessary, so as to make the middle vertical wire continue, throughout the whole field of view, on some distant and well defined point, while the telescope is elevated or depressed as it turns on the axis of the declination circle, to which the wire will in that case be perpendicular.

2. Slide the *object-glass* of the telescope in or out, while you view a star of the second magnitude, until the parallax of the wires is taken off, that is, until the vision is as distinct as possible.

3. To adjust the *level* of the *declination axis*. By the motion round the polar axis bring the bubble of the level to the middle of the tube, and in this situation make its scales or indices to coincide with both its ends; turn the level, end for end, and if it now stand in the middle, as before, the axis is level; if not, alter one half of the deviation from the truth by a slight motion round the polar axis, and the other half by the screws of the level itself; and repeat these rectifications till the bubble will stand always in the middle of the tube when its ends are reversed. But the bubble of a hanging level may also require a lateral adjustment; to examine it in this respect, turn it round on its

own axis a little, and if the bubble has a tendency to go to either end of the tube it must be rectified by the side screws till this tendency is removed, and then if the bubble will yet bear reversing, the level is properly adjusted.

4. To adjust the *pivot-holes* of the level *parallel* to the *axis* of the declination-circle, and the *axis horizontal*; bring the bubble of the level to the indices on the tube, with the level above the axis, by moving the instrument round the polar axis; then turn the declination-circle half round till the level is under its axis, and if the bubble now settles to the middle, as pointed out by the indices, the level is right; if not, alter one half of the error by turning the polar axis round, and the other half by the two screws that govern the pivot-hole; in the next place turn the telescope 90° round the declination-axis, and by the screws that govern the other pivot-hole, bring the bubble to the indices, and the axis will be horizontal, as well as the pivot-holes parallel to it in all directions; for when the level itself is adjusted, as above directed, it is evident that if the bubble keeps its place at the indices during a revolution of the declination-circle, the axis itself must necessarily be horizontal.

5. To set the *declination-axis* at *right angles* to the *polar axis*, we may use the level itself instead of the declination-axis, after it has been set parallel thereto as just directed; for this purpose, bring the bubble to the indices by moving round the polar axis, and bisect opposite points of the equatorial circle by the two wires of the microscopes; turn the instrument exactly half round by the help of the microscopes so adjusted, and if the bubble now settles to the indices, the two axes are at right angles to each other; if not, alter one half of the error by the slow motion of the polar axis, effected by the equatorial tangent screw, and the other half by the two screws at one end of the declination-axis adapted for this purpose.

6. To set the *line of collimation* true in *right ascension*, let the bubble be brought to the middle of the tube, or to the indices as in the last adjustment, and look at any well-defined small object near the horizon, as bisected by the middle vertical wire; then having noted this mark, turn the instrument half round the polar axis, as indicated either by the level or equatorial microscopes, which are now adjusted to do the same thing; and when the telescope is turned back round the declination-axis, note if the same object or mark be intersected as before, if not, alter one half of the deviation by the equatorial tangent screw, and the other half by moving the wires of the eye-piece in the telescope; thus when the same mark is bisected by the middle vertical wire, in reversed positions of the telescope, the line of collimation will be right with respect to right ascension.

7. To place the *indices* of the declination-circle to read *polar distances* truly. Before we describe this adjustment, it may be proper to remark, that the microscopes themselves of this circle have each three separate adjustments, the first, that which alters the power by altering the distance of the object lens, so as to make one minute on the circle equal to a revolution of the micrometer screw; the second, that which produces distinct vision by varying the distance of the entire microscope from the divisions of the circle; and the third, that which places zero on the scale of minutes to agree with zero on the declination-circle, and also zero on the scale of seconds, to agree with zero on the scale of minutes, as effected by the head of the micrometer being made to turn independently of the screw. These minor adjustments being understood, point the telescope to any distant land object, and let the middle horizontal wire bisect it, and read off the polar distances shewn by the indices, and take half their sum; make

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the same observation when the instrument is turned half round the polar axis, and take another mean of the angles now shewn by the opposite indices; subtract the former mean from  $180^\circ$ , and add the difference to the latter mean, and *half of this sum* is the angular distance from the pole of the instrument, to which quantity the indices must be put within the exactness of a minute or so, as this process must hitherto be considered as an approximation only: repeat the operation we have described of obtaining two means of polar distances more accurately by using the scales of minutes and seconds; thus, read off by the indices the quantity to the division next below the sub-divisions to be measured by the scales; then turn the micrometer head till the wire of the microscope bisects the next following point, taking care to count the notches passed over as minutes, and the seconds and parts on the micrometer scale to be added to the quantity given by the indices alone; and the *supplement* of the mean of the two measures by the microscopes, added to the mean read off in the same way, when turned half round the polar axis, being divided by two, will give the *true* angle from the pole of the instrument; and the scale of minutes, as well as scale of seconds on the micrometer head, must be finally adjusted thereto.

8. To place the *declination-level parallel to the line of collimation* of the telescope, bring the declination-axis level, or nearly so, and let the bubble of the declination-level be brought to the middle of its tube, by the motion round the

polar axis, and let the indices be put to its ends; turn the level a small quantity round its own axis, and try if the bubble has any tendency to either end; if it has, adjust it laterally by the screws that move one of its pivots sideways, till it is right in this respect; now reverse the level, and if the bubble does not stand in the middle, alter one half the error by moving the telescope in declination, by means of its screw for slow motion, and the other half by the screws that govern the pivots of the level, and the level itself will then be adjusted. In this situation of things look for some object in the centre of the field of the telescope, and note it; turn the instrument half round the polar axis, and as much round the declination-axis as to bring the telescope exactly to the same object again; if the bubble now stands in the middle, the adjustment is right, but if otherwise, one half of the error must be altered by the motion of the telescope in declination, and the other half by altering the pivot-hole of the level. Lastly, turn the instrument the space of *six hours* round the polar axis, and adjust the other pivot hole till the bubble stands in the middle of its tube, and the adjustments are all complete, provided the polar axis of the instrument be exactly parallel to the axis of the earth, which we have all along taken for granted, and which may be effected by its own adjustments as pointed out by an observation of a circum-polar star, agreeably to our directions given under our article *EQUATORIAL Sector*.

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N<sup>o</sup> I. TABLE of the Effect of Refraction in North Polar Distance.  
This correction is always +

Angle of the vertical with the horary circle.	Degrees of Altitude.															Angle of the vertical with the horary circle.																												
	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°																													
0	18	11	42	8	25	6	30	5	15	0	4	24	0	3	46	3	17	5	2	54	7	2	36	3	2	20	9	2	8	0	1	57	2	1	47	0	1	39	0	0	90			
2	18	0	11	42	8	24	6	30	5	15	3	23	8	3	46	3	17	4	2	54	6	2	36	2	2	20	8	2	7	9	1	57	1	1	47	5	1	38	9	88				
4	17	58	11	40	8	24	0	29	5	14	7	23	4	3	45	9	17	0	2	54	2	2	35	9	2	20	6	2	7	7	1	56	9	1	47	3	1	38	8	86				
6	17	55	11	37	8	22	6	28	5	13	8	4	22	5	3	45	0	3	16	4	2	53	7	2	35	4	2	20	1	2	7	3	1	56	6	1	47	0	1	38	5	84		
8	17	50	11	35	8	20	6	26	5	12	6	4	21	4	3	44	2	3	15	0	2	53	0	2	34	8	2	19	5	2	6	8	1	56	1	1	46	6	1	38	0	82		
10	17	44	11	31	8	17	6	24	5	10	8	4	20	0	3	43	0	3	14	5	2	52	0	2	33	9	2	18	8	2	6	1	55	4	1	46	0	1	37	5	80			
12	17	37	11	27	8	14	6	21	5	8	7	4	18	2	3	41	4	3	12	8	2	50	9	2	32	9	2	17	8	3	5	2	54	6	1	45	2	1	36	8	78			
14	17	29	11	21	8	10	6	18	5	6	1	4	16	2	2	39	7	3	11	0	2	49	5	2	31	7	2	16	7	2	4	0	53	7	1	44	4	1	36	1	76			
16	17	19	11	15	8	5	6	15	5	3	3	4	13	7	3	37	0	3	9	8	2	47	9	2	30	0	2	15	0	2	3	0	52	7	1	43	1	1	35	2	74			
18	17	8	11	7	8	0	6	11	5	0	4	4	11	1	3	35	3	3	7	8	2	46	1	2	28	7	2	14	0	2	1	0	51	5	1	42	3	1	34	1	72			
20	16	56	11	0	7	5	4	6	7	4	5	4	8	1	3	32	3	3	5	0	2	44	0	2	26	9	2	12	4	2	0	0	50	1	1	41	1	1	33	0	70			
22	16	41	10	5	7	4	0	5	1	4	5	4	4	8	0	2	29	3	3	2	2	42	0	2	24	9	2	10	0	1	0	0	49	7	1	39	7	1	31	8	68			
24	16	28	10	4	7	4	1	5	4	4	4	4	1	3	3	26	9	3	0	5	2	39	6	2	22	8	2	8	7	1	0	0	48	9	1	38	3	1	30	4	-66			
26	16	12	10	3	7	3	5	4	4	4	3	3	5	7	3	23	5	3	0	2	37	0	2	20	5	2	6	0	1	0	0	47	0	1	37	7	1	29	0	64				
28	15	55	10	2	7	2	6	3	4	4	3	3	5	3	1	20	0	3	0	2	34	5	2	18	0	2	4	4	1	0	0	46	0	1	36	8	1	27	4	62				
30	15	36	10	0	7	1	7	3	3	4	3	3	4	8	0	16	1	3	0	1	31	0	2	15	1	2	2	0	1	0	0	45	0	1	35	1	1	25	7	60				
32	15	17	9	5	7	0	8	5	3	1	2	3	4	3	0	12	0	2	0	2	28	1	2	12	6	1	5	9	5	1	0	0	44	5	1	33	4	1	24	0	58			
34	14	56	9	4	6	5	5	5	2	4	2	3	3	8	0	7	0	2	0	2	24	8	2	9	0	1	5	6	8	1	0	0	43	1	1	32	2	1	22	1	56			
36	14	34	9	2	6	4	6	5	1	6	4	2	3	3	3	3	0	2	0	2	21	3	2	6	5	1	5	4	0	1	0	0	42	6	1	31	0	1	20	1	54			
38	14	12	9	1	6	3	6	5	7	4	9	3	2	8	0	2	0	2	0	2	17	6	2	3	2	1	5	1	0	1	0	0	40	9	1	30	4	1	18	0	52			
40	13	48	8	5	6	2	7	4	5	9	4	2	3	2	2	2	0	2	0	2	13	7	1	5	9	1	4	7	9	1	0	0	38	0	1	29	8	1	15	0	50			
42	13	2	8	4	6	1	5	4	5	3	5	3	1	6	1	2	4	2	2	0	9	7	1	5	6	1	4	4	7	1	0	0	35	1	1	27	1	1	13	5	48			
44	12	58	8	2	6	3	4	0	3	4	7	3	9	9	2	4	2	2	2	0	5	0	1	5	2	4	1	4	1	4	1	0	0	32	1	1	24	4	1	11	0	46		
46	12	31	8	7	5	5	1	4	3	1	3	3	3	4	2	3	7	2	1	7	1	4	8	6	1	3	7	9	1	0	0	0	28	9	1	21	5	1	9	8	44			
48	12	3	7	4	5	3	4	2	1	3	3	2	5	6	6	2	3	1	2	1	5	6	9	1	4	4	6	1	3	4	1	0	0	25	6	1	18	5	1	6	2	42		
50	11	35	7	3	5	2	4	1	1	3	2	2	4	9	7	2	2	0	2	0	5	2	3	1	4	0	5	1	3	0	6	1	0	22	3	1	15	4	1	3	6	40		
52	11	0	7	1	5	1	4	0	0	3	1	2	4	2	5	2	1	0	2	0	4	7	5	1	3	6	0	1	8	8	1	0	0	19	3	1	12	2	1	1	0	38		
54	10	35	6	5	4	5	7	3	4	9	3	2	2	5	2	1	3	8	1	0	4	2	7	1	3	4	9	1	2	2	9	1	0	0	15	2	1	9	0	1	3	2	36	
56	10	4	6	3	4	4	2	3	3	8	2	2	2	7	6	2	6	6	1	0	5	0	5	1	3	7	7	1	2	7	4	1	0	0	11	6	1	5	6	1	0	1	34	
58	9	33	6	1	4	2	7	3	2	7	2	4	2	1	9	0	0	1	4	4	7	1	3	2	0	1	2	5	1	1	4	7	1	0	0	7	8	1	2	2	0	5	7	32
60	9	0	5	5	1	4	1	2	3	1	5	2	2	1	2	0	1	5	3	2	1	3	8	7	1	2	7	3	1	1	8	1	0	0	4	0	0	5	8	0	5	3	30	
62	8	27	5	3	3	5	7	3	3	2	2	8	2	3	9	1	4	6	3	1	3	2	7	1	2	2	2	1	1	3	3	1	0	0	0	1	0	1	5	5	0	5	0	28
64	7	54	5	8	3	4	1	2	5	1	2	1	5	5	7	1	3	9	3	1	2	6	6	1	1	6	0	1	8	5	1	0	0	0	5	6	1	0	5	1	4	0	26	
66	7	19	4	4	3	2	5	2	3	9	2	8	1	4	7	1	3	2	1	2	0	3	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	24
68	6	45	4	2	3	9	2	2	6	1	5	8	1	3	8	9	1	4	0	1	5	5	0	5	8	5	0	5	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	22
70	6	10	4	0	2	5	2	1	3	1	4	8	1	3	0	3	1	7	5	1	7	6	0	5	9	5	0	5	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	20
72	5	34	3	3	2	3	6	2	1	1	3	7	1	2	1	6	1	9	9	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	18
74	4	58	3	1	3	1	9	1	4	7	1	2	1	1	2	8	1	2	1	0	5	4	5	0	4	8	1	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	16
76	4	22	2	5	0	2	2	1	3	4	1	1	3	9	0	5	4	8	0	4	7	8	0	4	2	1	0	3	7	8	0	0	0	0	0	0	0	0	0	0	0	0	14	
78	3	45	2	2	1	4	1	2	1	5	0	5	4	0	0	4	7	1	0	4	1	1	0	3	6	1	0	3	2	5	0	0	0	0	0	0	0	0	0	0	0	0	12	
80	3	8	2	2	1	2	7	1	7	0	5	5	8	0	3	9	3	0	3	4	3	0	3	0	2	0	2	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
82	2	30	1	3	8	1	0	0	5	4	0	5	6	7	0	3	1	0	2	7	5	0	2	4	0	2	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	
84	1	53	1	1	3	0	5	3	0	4	1	0	2	7	6	0	2	3	5	0	2	0	7	0	1	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
86	1	13	0	0	9	0	3	0	2	7	0	1	8	4	0	1	5	5	0	1	3	7	0	1	2	3	0	1	0	0	0	0	0											





# EQUATORIAL.

N° II. TABLE of the Effect of Parallax in North Polar Distance and Right Ascension.

The horizontal Parallax = 8".6 This correction is always -

Angle of the vertical and horary.	Degrees of Altitude.										Angle of the vertical and horary.							
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°								
0	8.60	"	8.08	"	7.45	"	6.59	"	5.53	"	4.30	"	2.94	"	1.49	"	0.0	0°
10	8.47	8.34	7.96	7.74	6.49	5.45	4.23	2.90	1.47	0.0	0.0	90						
20	8.35	7.96	7.60	7.00	6.19	5.20	4.04	2.77	1.40	0.0	0.0	80						
30	7.45	7.34	6.99	6.45	5.71	4.79	3.72	2.55	1.29	0.0	0.0	60						
40	6.59	6.49	6.18	5.70	5.05	4.23	3.20	2.25	1.15	0.0	0.0	50						
50	5.53	5.44	5.19	4.79	4.23	3.55	2.76	1.89	0.95	0.0	0.0	40						
60	4.30	4.23	4.04	3.72	3.30	2.76	2.15	1.47	0.74	0.0	0.0	30						
70	2.94	2.90	2.77	2.55	2.26	1.89	1.47	1.01	0.51	0.0	0.0	20						
80	1.49	1.47	1.40	1.29	1.14	0.95	0.75	0.50	0.26	0.0	0.0	10						

Parallax in Right Ascension, × Sec. of Declination.

This correction is + on the East, and - on the West side of the Meridian.

N° III. TABLE of the Effect of Parallax in North Polar Distance and Right Ascension

The horizontal Parallax being = 10". This correction is always -

Angle of the vertical and horary.	Degrees of Altitude.										Angle of the vertical and horary.	
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°		
0	"	"	"	"	"	"	"	"	"	"	"	0°
10	10.00	9.85	9.40	8.66	7.66	6.43	5.00	3.42	1.73	0.0	0.0	90
20	9.85	9.70	9.26	8.53	7.54	6.33	4.92	3.37	1.70	0.0	0.0	80
30	9.40	9.25	8.83	8.14	7.20	6.04	4.70	3.21	1.63	0.0	0.0	70
40	8.66	8.51	8.14	7.51	6.64	5.57	4.33	2.96	1.50	0.0	0.0	60
50	7.66	7.54	7.20	6.63	5.87	4.93	3.83	2.62	1.32	0.0	0.0	50
60	6.43	6.33	6.04	5.56	4.92	4.13	3.21	2.21	1.11	0.0	0.0	40
70	00	4.92	4.70	4.33	3.83	3.21	2.50	1.71	0.86	0.0	0.0	30
80	42	3.37	3.21	2.96	2.62	2.20	1.71	1.17	0.59	0.0	0.0	20
90	73	1.71	1.63	1.50	1.33	1.11	0.87	0.59	0.30	0.0	0.0	10

Parallax in Right Ascension, × Sec. of Declination.

This correction is + on the East, and - on the West side of the Meridian.

N° IV. TABLE of Natural Secants.

Deg.	Nat. Sec.										
1	1002	16	10403	31	11666	46	14396	61	20627	76	41336
2	1006	17	10457	32	11792	47	14663	62	21301	77	44454
3	1014	18	10515	33	11924	48	14945	63	22027	78	48097
4	1024	19	10576	34	12062	49	15243	64	22812	79	52408
5	1038	20	10642	35	12208	50	15557	65	23662	80	57588
6	1055	21	10711	36	12361	51	15890	66	24586	81	63925
7	1075	22	10785	37	12521	52	16243	67	25593	82	71853
8	1098	23	10864	38	12690	53	16626	68	26695	83	82055
9	10124	24	10946	39	12868	54	17013	69	27904	84	95668
10	10154	25	11034	40	13054	55	17434	70	29238	85	114737
11	10187	26	11126	41	13250	56	17883	71	30716	86	143356
12	10223	27	11223	42	13456	57	18361	72	32361	87	191075
13	10263	28	11326	43	13673	58	18871	73	34203	88	286537
14	10306	29	11434	44	13902	59	19416	74	36280	89	572987
15	10353	30	11547	45	14142	60	20000	75	38637	90	Infinite.

# EQUATORIAL.

N<sup>o</sup> V. TABLE of the Correction of the Time shewn by an Equatorial on account of Refraction, when the Instrument is not previously adjusted to the true Meridian.

Angle of the Vertical with the Hourly Circle.	Degrees of Altitude.												
	7°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°
0	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
5	338.	241.	161.3	118.9	94.2	74.9	62.0	51.7	43.7	36.8	25.3	16.1	8.0
10	169.	120.	80.7	59.4	47.0	37.4	31.0	25.9	21.9	18.4	12.6	8.1	4.0
15	114.	81.	54.3	40.0	31.8	25.2	20.9	17.4	14.7	12.4	8.5	5.4	2.7
20	86.	61.	41.0	30.4	24.1	19.1	15.8	13.2	11.2	9.4	6.5	4.1	2.1
25	70.	50.	33.4	24.6	19.5	15.5	12.8	10.7	9.1	7.6	5.2	3.3	1.7
30	59.	42.	28.2	20.6	16.4	13.0	10.8	9.0	7.6	6.4	4.4	2.8	1.4
35	51.	36.	24.4	18.0	14.3	11.4	9.4	7.8	6.6	5.6	3.8	2.4	1.2
40	46.	33.	21.8	16.0	12.7	10.1	8.4	7.0	5.9	5.0	3.4	2.2	1.1
45	41.	30.	19.9	14.6	11.8	9.2	7.6	6.3	5.4	4.5	3.1	2.0	1.0
50	38.	27.	18.3	13.4	10.7	8.5	7.1	5.9	5.0	4.2	2.9	1.8	0.9
55	36.	26.	17.1	12.6	10.1	7.9	6.6	5.5	4.6	3.9	2.7	1.7	0.9
60	34.	24.	16.2	11.9	9.5	7.5	6.3	5.2	4.4	3.7	2.5	1.6	0.8
65	32.	23.	15.5	11.4	9.1	7.2	6.0	4.9	4.2	3.5	2.4	1.5	0.8
70	31.	22.	14.9	11.0	8.8	6.9	5.8	4.8	4.0	3.4	2.3	1.5	0.7
80	30.	21.	14.2	10.5	8.3	6.6	5.5	4.6	3.9	3.2	2.2	1.4	0.7
90	29.	21.	14.0	10.3	8.2	6.5	5.4	4.5	3.8	3.2	2.2	1.4	0.7

× Secant of Declination.

This Equation is — on the East, and + on the West side of the Meridian.

N<sup>o</sup> VI. TABLE shewing the Correction of the Meridian Line found by an Equatorial, arising from the Effect of Refraction, in Minutes and Decimals.

Angle of the Vertical with the Hourly Circle.	Degrees of Altitude.												
	7°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°
0													
5	84.5	60.3	40.0	29.8	21.9	18.3	15.5	12.6	10.9	9.2	6.3	4.0	2.3
10	41.7	29.7	19.8	14.8	11.4	9.1	7.7	6.2	5.4	4.5	3.1	2.0	1.1
15	27.3	19.5	13.1	9.7	7.5	5.9	5.0	4.1	3.5	3.0	2.0	1.3	0.7
20	20.1	14.4	9.6	7.2	5.5	4.4	3.7	3.0	2.6	2.2	1.5	1.0	0.5
25	15.8	11.4	7.6	5.6	4.3	3.4	2.9	2.4	2.0	1.7	1.2	0.8	0.4
30	12.7	9.1	6.1	4.5	3.4	2.8	2.3	1.9	1.6	1.4	0.9	0.6	0.3
35	10.2	7.5	5.0	3.7	2.8	2.3	1.9	1.6	1.3	1.1	0.8	0.5	0.3
40	8.7	6.2	4.2	3.1	2.4	1.9	1.6	1.3	1.1	0.9	0.6	0.4	0.2
45	7.3	5.2	3.5	2.6	2.0	1.6	1.3	1.1	0.9	0.8	0.5	0.3	0.2
50	6.1	4.4	2.9	2.2	1.7	1.3	1.1	0.9	0.8	0.6	0.4	0.3	0.2
55	5.1	3.7	2.4	1.8	1.4	1.1	0.9	0.8	0.7	0.5	0.4	0.2	0.1
60	4.2	3.0	2.0	1.5	1.1	0.9	0.8	0.6	0.5	0.4	0.3	0.2	0.1
65	3.4	2.4	1.6	1.2	0.9	0.8	0.8	0.5	0.4	0.3	0.2	0.2	0.1
70	2.7	1.9	1.3	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1
80	1.3	0.9	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.0
90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

× Secant of the Altitude.

Note. If the observation is on the  $\left\{ \begin{array}{l} \text{east} \\ \text{west} \end{array} \right\}$  side of the Meridian, then is the true Meridian so many minutes to the  $\left\{ \begin{array}{l} \text{east} \\ \text{west} \end{array} \right\}$  of that found by the Instrument.

# EQUATORIAL.

N<sup>o</sup> VII. TABLE of the Effect of Refraction in Right Ascension in Time, when the Equatorial is adjusted to the Meridian.

Angle of the vertical with the horary Circle.	Degrees of Altitude.														
	3°	5°	7°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°
0	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
5	5.1	3.5	2.5	1.8	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1
10	10.1	6.9	5.1	3.7	2.5	1.8	1.4	1.1	0.9	0.8	0.7	0.5	0.4	0.3	0.1
15	15.0	10.3	7.6	5.4	3.6	2.7	2.1	1.7	1.4	1.2	1.0	0.8	0.6	0.4	0.2
20	19.9	13.5	10.0	7.2	4.8	3.5	2.8	2.2	1.9	1.4	1.2	1.1	0.7	0.5	0.2
25	24.5	16.6	12.3	8.8	5.9	4.3	3.4	2.7	2.3	1.9	1.6	1.3	0.9	0.6	0.3
30	29.0	19.7	14.6	10.5	7.0	5.2	4.1	3.3	2.7	2.3	1.9	1.7	1.1	0.7	0.3
35	33.4	22.7	16.8	12.0	8.0	5.9	4.7	3.7	3.1	2.6	2.2	1.8	1.3	0.8	0.4
40	37.4	25.4	18.6	13.5	9.0	6.7	5.2	4.2	3.4	2.9	2.4	2.1	1.3	0.9	0.4
45	41.3	28.0	20.7	14.9	9.9	7.3	5.7	4.6	3.9	3.2	2.7	2.3	1.5	1.0	0.5
50	44.7	30.3	22.5	16.1	10.7	7.9	6.2	5.0	4.1	3.5	2.9	2.5	1.7	1.1	0.5
55	47.7	32.4	24.0	17.2	11.5	8.5	6.7	5.3	4.4	3.7	3.1	2.7	1.8	1.1	0.5
60	50.3	34.2	25.3	18.1	12.1	8.9	7.0	5.7	4.7	3.9	3.3	2.8	1.8	1.2	0.6
65	54.8	35.9	26.5	19.0	12.8	9.3	7.4	5.9	4.9	4.2	3.5	2.9	2.0	1.3	0.6
70	54.6	37.0	27.5	19.7	13.1	9.7	7.7	6.1	5.1	4.3	3.5	3.0	2.1	1.3	0.6
80	57.6	39.1	28.9	20.7	13.8	10.1	8.0	6.5	5.3	4.5	3.8	3.2	2.2	1.4	0.7
90	58.4	39.6	29.3	21.0	14.0	10.3	8.2	6.5	5.4	4.5	3.8	3.2	2.2	1.4	0.7

× Secant of Declination.

This Correction is — on the East, and + on the West side of the Meridian.

N<sup>o</sup> VIII. TABLE of the Effect of Refraction in Declination when the Equatorial is adjusted to the Meridian.

Angle of the vertical with the horary Circle.	Degrees of Altitude.														
	3°	5°	7°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°
0	1 36	1 54	1 20	1 15	1 30	2 35	2 2	1 38	1 21	1 8	57	48	33	21	10
10	14 24	9 46	7 14	5 11	3 27	2 32	2 0	1 37	1 20	1 7	57	48	33	21	10
20	13 39	9 16	6 52	4 56	3 17	2 26	1 55	1 32	1 16	1 4	53	45	31	20	9
25	13 12	8 59	6 38	4 45	3 10	2 20	1 50	1 29	1 14	1 2	52	44	30	19	9
30	12 35	8 33	6 20	4 32	3 1	2 14	1 45	1 25	1 10	0 59	49	42	29	18	9
35	11 55	8 6	6 0	4 18	2 52	2 7	1 40	1 20	1 6	0 56	46	39	27	17	8
40	11 11	7 35	5 37	4 1	2 40	1 59	1 33	1 15	1 2	0 52	43	37	25	16	8
45	10 19	7 0	5 11	3 43	2 28	1 50	1 26	1 9	0 58	0 48	40	34	23	15	7
50	9 22	6 21	4 42	3 22	2 15	1 40	1 18	1 3	0 52	0 44	36	31	21	14	6
55	8 21	5 40	4 12	3 0	2 0	1 29	1 10	0 56	0 46	0 39	33	27	19	12	6
60	7 16	4 56	3 39	2 37	1 45	1 18	1 1	0 49	0 40	0 34	29	24	16	11	5
65	6 7	4 9	3 4	2 12	1 28	1 5	0 51	0 41	0 34	0 28	24	20	14	9	4
70	4 58	3 22	2 30	1 48	1 12	0 53	0 42	0 33	0 28	0 22	19	16	11	7	3
75	3 45	2 34	1 54	1 21	0 54	0 40	0 32	0 25	0 21	0 18	15	12	9	6	3
80	2 32	1 43	1 16	0 55	0 37	0 27	0 21	0 17	0 14	0 12	10	8	6	4	2
85	1 16	0 52	0 38	0 27	0 18	0 13	0 11	0 9	0 7	0 6	5	4	3	2	

## EQUATORIAL.

### *Explication and Use of the Tables.*

The three first tables are particularly calculated for the use of a large equatorial instrument, for the purpose of clearing observations made with it from the effects of refraction and parallax, when neither Dollond's refraction apparatus is used, nor the micrometer circle of Ramsden's for adjusting the wire used in taking altitudes; but the four last are adapted more peculiarly for portable instruments. They are copied from sir George Shuckburgh's account in the Philosophical Transactions, and, being adapted for all latitudes, are a suitable appendage to the descriptions we have given of the different instruments.

Table I. gives the correction of the refraction in north polar distance, by entering it with the altitude at the top, and the angle of the horary and vertical circles on the left hand side; and in the common point of meeting is found a quantity in seconds and decimal parts, that is in all cases to be added to the apparent polar distance to give the true; but if it be entered with the angle of the horary and vertical circle in the right hand column, it will give the refraction in right ascension, by multiplying the quantity here found by the secant of the declination to be found in Tab. IV., which is a readier operation than dividing by the cosine, and amounts to the same thing.

Table II. gives the effect of the sun's parallax in right ascension and north polar distance, and is to be entered with the same arguments as Tab. I.; and the parallax in right ascension is to be multiplied by the secant of the declination as before; the sun's horizontal parallax being assumed = 8".6.

Table III. is a similar table, only calculated to an horizontal parallax of 10"; so that whatever be the parallax of the sun or planets, this correction may readily be found, almost by inspection, viz. by multiplying the tabular number by the exact quantity of parallax of the body observed, and cutting off the decimal quantity.

Table IV. contains the natural secants to each degree, extracted from Sherwin's tables, to be ready for the operations required above.

Table V. gives the correction of the time; viz. of the sun or star's distance from the meridian, as ascertained by a portable instrument not previously adjusted to the meridian; this quantity also is to be multiplied by the secant of the declination.

Table VI. gives the correction of the meridian line in minutes and decimals, which may be near enough for portable instruments; but the quantity here found must be multiplied by the secant of the altitude.

Table VII. (like Table I.) is adapted to seconds of time, and gives the refraction in right ascension in terms suited to such instruments as have the equatorial circle divided into hours and minutes.

Table VIII., in like manner, gives the refraction in declination. The arguments are the same in all the tables.

These tables were constructed by sir G. S. in the year 1774, for his own use, and were founded on the principles explained by the Hon. S. M'Kenzie in fig. 4. of Plate XIII., where I F is a portion of a vertical circle = the refraction in altitude; C F a parallel to the equator; I C a portion of an horary circle = the refraction in declination, found by Tab. I. and Tab. VIII., the angle C I F, the angle of the horary and vertical circle; C F the refraction in right ascension, found by Tab. I. and Tab. VII.; D I (a parallel to the horizon) the correction of the meridian, found by Tab. VI.; and D F the correction of the time, found by Tab. V.; and as I F will hardly ever be found to exceed 30', these triangles have been considered all as plane; making due

allowance, in the proportion of the sine to the radius, for the distances of the arcs D I, F C, and D F, from their respective poles, which has been noticed at the foot of each table. The refraction in altitude was taken from Mayer's Tables, 1770, London; which is calculated for a density of the air expressed by 29.6 inches of the barometer, and 50° of Fahrenheit's thermometer.

EQUATORIAL Micrometer, is an apparatus applied to a telescope, that has an equatorial motion, for the purpose of measuring small differences of right ascension and declination of any two heavenly bodies, that pass either successively, or at the same time nearly, through the field of view, so as to be both visible at the same elevation of the telescope. This method requires no graduated circles with verniers or compound microscopes, and yet is capable of great accuracy within certain limits of difference between the relative situations of the bodies to be compared together; and if the right ascension and declination of one of the two observed bodies be previously known with sufficient accuracy, the place of the other can be determined therefrom by the observed differences. The common wire micrometer has been long in use as an appendage to the eye-piece of a telescope, and was used by Dr. Bradley in making astronomical observations, his manner of doing which was communicated to the Royal Society in the year 1772 (vol. lxiii.) by Dr. Maskelyne; but as the telescopes then in use were from ten to fifteen feet long, for want of the achromatic object-glasses, an equatorial motion was given, not from one centre, but by means of supporters at each end of the wooden tubes, so contrived as to be manageable both in altitude and azimuth; which apparatus is still preserved at the Royal Observatory. The wires of the micrometer have been adapted differently by different makers, some making only one moveable, and some more; but they all agreed in placing them in the focus of the eye-piece of the telescope. It is not, however, our intention to enter into a detail in this place of all the different constructions of the micrometer, as applied to various purposes, but to confine ourselves to a notice of those that have been more particularly applied to telescopes having an equatorial motion. For the other constructions, we refer to the article MICROMETER.

Soon after the discovery of the properties of the achromatic object-glass of a telescope had reduced the length of the astronomical telescope to a portable size, without diminishing either its power or size of its field of view, not only were equatorial instruments contrived of various constructions, as we have already described, but equatorial stands for simple telescopes were invented, and continue to be in use with the best telescopes to the present day. To these telescopes the micrometers are a very necessary and useful appendage, inasmuch as they render it capable of being applied with advantage in ascertaining the right ascension and declination of a comet, planet, or other body out of the meridian, when they happen to be near enough to a known body to admit of being taken into the same field of view without altering the elevation. Though the wire micrometer was first invented, as applied to the focus of the eye-piece, and continues to be used in many instruments, yet since the invention of the achromatic object-glass, Dollond's object-glass micrometer has by some astronomers been preferred, or at least deemed equally useful, particularly when the cross wires are also used in conjunction, as described by Dr. Maskelyne in his paper on this subject read to the Royal Society of London on Dec. 12, 1771, which was the year after Smeaton finished his wire micrometer, that had been begun about forty years before. If we give

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an account of these two kinds of micrometers in succession, the reader will perceive the varieties that may arise from them by slight deviations of construction. We will begin with Smeaton's, as being of prior origin:

We are not aware that Mr. Smeaton has left behind him any perspective drawing of his equatorial micrometer, though we have heard that there is an undescribed sketch of one among his papers, at present in the possession of Mr. Lloyd; but there is a section of one accompanying his paper read to the Royal Society of London on June 7, 1787, which is sufficient for explaining the principle of its application. *Fig. 3. of Plate XIII. of Astronomical Instruments*, is the said section, as viewed from the eye-end of the telescope. "This micrometer," says the author, "is furnished with five horary wires, denominated in their order, *a, A, B, C, D*, (*B* being the middle horary wire,) and the two declination wires are denominated *A, B*, each moveable by a separate and independent micrometer-screw, from the outside of the field to the centre, and a little beyond it; so that each wire can be moved into the place of the other, when at or near the centre." The field of view was only  $1^{\circ} 17'$ , and the magnifying power as low as 20, with an eye glass of  $1\frac{1}{2}$  inch focus, and a double object-glass of  $34\frac{2}{3}$  focal length; notwithstanding the author calculates that a difference of only  $2\frac{1}{4}''$  may be read by such apparatus, which he concluded was near enough for any instrument to read out of the meridian. In the construction of the stand every thing was done to ensure stability of position at any given elevation, and the frustum of an hexagonal stone was used as a pedestal, detached from the floor of the observatory. With an apparatus so steady, it was not necessary to confine the observations to two bodies, to be compared, whose difference of right ascension was only a few minutes, but even hours could be admitted of for the interval of the successive transits, provided the difference of the declinations did not exceed the interval between the two adjustable cross wires. The difference of the right ascensions was easily ascertained by a regulator or chronometer, measuring the interval between the transits, and the distance between the bodies as measured by the interval between the cross wires, gave the difference of the declinations. The first trial of the steadiness and accuracy of this apparatus was made with Saturn and  $\gamma$  Capricorni, from which it was found that the star had the same right ascension and declination, determined on two separate evenings, at the distance of 48 hours, though the instrument had not been touched during the interval. But the principal observations noticed in the memoir, are those relating to the elongation of Mercury, as taken from Sep. 23, to Oct. 13, 1786, the result of which was, that at  $5^{\text{h}} 22^{\text{m}} 35'$  mean time on Sep. 23, A.M. Mercury's right ascension, deduced from a comparison with  $\alpha$  Orionis, was  $163^{\circ} 59' 21''$ , and his declination north  $7^{\circ} 44' 25''$ . For the particulars of the calculations and the tables of the observations, see the *Phil. Trans. of 1787*. Also for the manner in which a simple telescope may be made to move in an equatorial direction, see our article *Equatorial Stand of a telescope*.

The object-glass micrometer of Dollond, of his most improved construction, is represented by *fig. 4. of Plate XII.* agreeably to a drawing given in Mr. Dollond's pamphlet that accompanies his equatorial instrument. By the improvement, says the author, this micrometer has received, it is rendered capable of being applied to telescopes of small aperture; the focal length of the object-glass being considerably increased, the scale by which the angles are measured is much enlarged. By this increase in the focal length of the object-glass of the micrometer,

the perfection of the telescope is less injured; but the greatest advantage that is derived from the improvement, is the length of the segments, which admit of the whole aperture of the telescope, even in measuring the largest diameters of the sun or moon, and the object retains the same brightness in measuring the largest angles as in measuring the smallest.

Notwithstanding these several advantages, the instrument is greatly reduced in size, as will appear by inspecting the figure representing the micrometer on the end of the telescope; the description of which is as follows:—

*a* and *b* are two long segments of an achromatic object-glass, divided into separate pieces by a diametrical line, and fitted into separate frames, so that by sliding one or both the segments, they may be made to form in effect either one object-glass or two, it being the property of half a well ground glass to give as distinct an image as the whole would do; the segment *a* is moved by turning the milled head *c*, and the segment *b* is moved by turning the handle *d*. When an observation is to be made, it is generally known what number of minutes the angle will contain nearly; suppose, for example, the diameter of the sun were to be measured, which is known to be about  $32'$ ; move the segment *a* till the index *e* comes to 32 on the scale *ff*, then looking through the telescope, move the segment *b*, by turning the handle *d* till the circumferences of the two images, formed respectively by the two segments, are brought to touch one another externally, and the quantity that the segments have moved will be measured by the scale *gg*, and vernier *b*, by which an inch is divided into five hundred parts: the greatest exactness is required in this scale, as the angle is absolutely to be determined by the measure taken with it; the scale *ff* being only of use to set the segment *a*, so that in measuring the angle by moving the segment *b*, they may be both moved nearly the same quantity.

The handle *i* is to turn the micrometer round, to bring the line dividing the two segments of the object-glass into the plane passing through the two objects, whose distance is to be measured. It is necessary, in making observations with the micrometer, that the telescope, when the micrometer is on, be adjusted to the *most perfect vision* of the object to be observed, as a small error in this respect may occasion a considerable difference in the observation. To find if there is any error in the adjustment of the micrometer scale *gg*, turn the handle *d*, so as to make the two images perfectly unite, and the number shown by the scale and vernier will be the error of adjustment, if there is any; this error may either be allowed for in the observations, or be corrected by the vernier screws at *k*. The object proper to be used for adjusting the focus of the telescope with the micrometer on, may be any of the celestial bodies, or some distant well defined land object; but for adjusting the micrometer scale, the object may be nearer, such as a printed paper at two or three hundred feet distance, provided the focus be first well adjusted to this object. A table is usually given with the micrometer, which shews the number of minutes and seconds answering to the divisions on the scale. When the micrometer is on the end of the tube of the telescope, it is necessary that the screw at the centre of motion be tight, otherwise, which is better, that there be a counterpoise at the eye-end to preserve the equilibrium in any elevation. Also, as the object-glass of the micrometer is concave, the common focus of the object-glass of the telescope end of it is lengthened, which circumstance requires the tube of the eye-glass

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to be longer than when the telescope is used without the micrometer.

The properties peculiarly ascribable to the two kinds of micrometers we have described are, that the one at the focus of the eye-glass is adapted for measuring the differences of right ascensions and declinations of two bodies, one of which has its plane known; but the one placed at the object end of the telescope is calculated, by means of its graduated scale, to measure absolute small distances; and the accuracy of its scale may be brought to the test by a comparison with a known interval between two stars or other distant bodies. Dr. Maskelyne, in the paper we have already noticed, has however shewn how, by the addition of two cross-wires in the focus, the differences of right ascensions and declinations may also be measured by Dollond's micrometer, thus: "Suppose it be required to measure the difference of right ascension and declination of two stars, whose difference of declination does not exceed the extent of the scale of the micrometer, and the distance of the meridians passing through the stars does not exceed the semi-diameter of the field of view, turn the wires about till the western star runs exactly along the cross-wire by the diurnal motion; then separate the two segments of the divided object-glass to a convenient distance, and turn the micrometer about, by means of its proper handle, till the two images of the same star, formed by the two segments of the object-glass, pass the horary or vertical wire at the same instant. Lastly, partly by the feet-screws of the stand, and partly by the handle that separates the segment, cause the southernmost image of the northernmost star, and the northernmost image of the southernmost star to appear both upon and run along the cross or horizontal wire: the numbers standing upon the scale of the micrometer will then shew the difference of declination of the said stars; and if the times be noted when they pass successively the horary or vertical wire, the difference of the two times will give the difference of their right ascensions also." (See Phil. Trans. vol. lxi. article xlix.) It was one of Dollond's object-glass micrometers, attached to an 18 inch reflecting telescope by Short, and another attached to a two feet reflector, that lieutenant (afterwards captain) J. Cook, of the Endeavour, and Mr. Charles Green; formerly assistant at the Royal Observatory, used in observing the transit of Venus over the sun's disc on June 3, 1769, in King George's island, or Otaheite, in the South sea, as recorded in the same volume of the Philosophical Transactions.

For an account of the history of the micrometer, and its various constructions by different artists and ingenious men, see the article MICROMETER.

**EQUATORIAL Sector**, an instrument sometimes used in *Practical Astronomy*. This instrument was invented by Mr. George Graham, F. R. S. for measuring greater differences of right ascension and declination of a heavenly body, as compared with another body, than the equatorial micrometer alone will give, and may be made of any convenient dimensions. One of these instruments made by Mr. Graham, is yet preserved at the Royal Observatory at Greenwich, and is occasionally employed to determine the right ascensions and declinations of a comet or other body out of the meridian, for doing which it is still found to be serviceable. Doctor Robert Smith has described the principle and construction of Graham's sector, in the year 1738, and Mr. B. Martin copied the account verbatim in his magazine, from one or other of which authors the different dictionaries have their description transcribed.

*Graham's Equatorial Sector.*—In justice to the contriver

of the equatorial sector, we propose to describe it agreeably to its original construction; but as we have copied the different parts of the drawings, as given by Dr. Smith, to be thrown into one perspective instrument, it becomes necessary to vary the detail accordingly. *Fig. 1. of Plate XIII. (of Astron. Instr.)* is a perspective view of the principal parts of the sector lying in its inclined stand or bed, which we have supposed to be firmly fixed to a sloping pedestal, exactly parallel to the earth's axis. This inclined bed, A B, is a strong brazen plate or bar, turned up at the ends in a perpendicular direction at C and D; the lower end C has a screw, entering it from below, strong enough to bear the inferior end of the sector's axis E F G, the conical hole made in the end of the latter at E, resting on the conical point of the former; the upper end D has a slit in it, into which the axis is demitted at the cylindrical part F, below the circular plate H attached to the axis. The whole length of the axis is 18 inches, of which the square part E F is 12. On the posterior part of the bent end D of the inclined supporting plate A B, is a clamp I, turning on two pivots, so that it may be elevated or depressed without turning round in an equatorial direction; this clamp fixes the circular plate H, in any given place on its edge from turning round, but adapts itself to the plate, so as to press equally on both surfaces, by means of its vertical motion on pivots; consequently the axis E F G, to which the plate H is attached, may have a motion like the polar axis of the earth when wanted, and may be firmly fixed by the clamp acting on its plate in any given situation. At the superior end G of the axis is fixed another circular brazen plate K L on one of the flat sides of the squared axis, and having a motion round a pin with screws and a tightening collar; on this plate a cross of brass is screwed fast, composed of four bars at right angles to each other, two of which bars constitute an inverted cock, on the bent parts of this the long radial bar M N is fixed, which is made strong by an edge-bar on its under side. Whenever, therefore, the circular plate K L moves round its central pin at G, the radial bar, carried by it, partakes of its motion, and *vice versa*; this plate has also a clamp O, similar to the clamp I in every respect, by which it may be made steady in any given situation. The length of the radial bar is  $2\frac{1}{2}$  feet, and its breadth at M and N  $1\frac{1}{2}$  and 2 inches respectively: at N is a small arch of a circle, 6 inches long and  $1\frac{1}{2}$  broad, graduated into  $10^\circ$ , and subdivided into quarters, that read and are figured both ways. Upon this radial bar is mounted a telescope P, of  $2\frac{1}{2}$  feet in length, moveable on the point M, as an axis of motion, near the object-end, and having a vernier near the eye-end with 16 quarters of a degree divided into fifteen equal parts, so as to read off exact minutes. This vernier is moved by the nut of an endless screw Q, that is adapted as an apparatus for fast or slow motion, in the usual way. The diameters of the two circular plates are each 5 inches, and the plates are strong enough to hold the telescope in any given position that an observed body may require.

The polar axis E F G of this instrument must be placed *truly* in the meridian and parallel to the earth's axis, which may be done by bringing the telescope parallel to the axis itself, and, after fixing it, by following a circumpolar star therewith, and noting the apparent path as it respects the intersection of the cross-wires of the telescope: the deviation above or below the cross-wire will point out the error of elevation of the axis, and the difference in the times of the star's passage through the two semicircles, east and west respectively, will discover the deviation from the meridian

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line; then half these errors may be corrected by the screws that fix the inclined bar *AB* to the pedestal, and the other half by altering the position of the telescope, till, after several successive trials, the star will accompany the intersection of the wires through its entire circle. It is necessary, however, that the polar axis be placed, by means of a small quadrant or other such contrivance, very nearly in its proper degree of elevation, as well as nearly in the meridian on the pedestal previously to the adjustment by a circumpolar star. It is also necessary that the line of collimation of the telescope be parallel to the plane of the sector, as well as the latter at right angles to the circular plate *H*, which represents the equator; the former may have its truth examined by a distant plumb-line suspended in a vertical position; for if the intersection of the cross-wires of the telescope will pass along this line, when the plane of the sector is vertical, and when the telescope derives its motion from the screw of the vernier alone, it may be concluded that the line of collimation is parallel to the plane of the sector; but the plane of the sector itself must be previously set right, as it regards the equatorial plate *H*, by the screws that fix it to the inverted cock of the cross, attached to the circular plate *KL*. From a consideration of this instrument, as we have described it, it is obvious, that, provided the telescope, thus having a polar motion and bearing a graduated sector, be made perfectly steady, and placed in the true direction of an hour circle in the heavens, the difference of declination of any two bodies in the celestial regions, that does not exceed the extent of the sector's limb, may be measured to the accuracy of a minute of space, and that whether the two bodies pass the telescope together or successively, provided the elevation of the telescope does not vary in the mean time; and also the difference of right ascension of any two bodies, similarly situated, may be had by noting the difference of sidereal time, (by a regulator,) of their passages over the horary wire; provided the situation of the sector itself does not alter while the telescope is raised or depressed; but much of the accuracy of the results will depend on the steadiness of the parts that are clamped. Were the equatorial sector to be constructed at this time, the reading by a microscopic micrometer would greatly enlarge the powers of this instrument.

"But however well adapted this instrument may be to the purposes for which it was intended," says professor Vince (*Treatise on Pract. Astron.* p. 141, and sec. 7.) "yet it will not conveniently admit of a large telescope; Dr. Maskelyne, therefore, thought of a construction which would admit of one of a larger size, and which has, besides, several other advantages in respect to the adjustments, as will be evident when we come to describe them. The instrument was made by Mr. Sisson, the construction of which we will first describe, and then proceed to its adjustments."

*Equatorial sector by Mr. Jonathan Sisson.*—*AB*, in *fig. 1.* of *Plate XVII.* (of *Astron. Infl.*) is a polar axis, *HI* a circle fixed upon, and at a small distance from it, on the centre of which is an axis, about which the telescope *CD* turns, carrying the indices *a, b*, each having a vernier which subdivides to minutes, and the circle is graduated to shew north polar distances; this, which is called the cross axis, goes through *AB* into a fixed case *E* on the other side, and is moveable by a screw *q* in order to fix it perpendicular to the polar axis: *LM* is an arc of  $22^\circ$  fixed upon *AB*, and concentric with *HI*; *vw* is a vernier whose arm *K* may be screwed to the axis on which the telescope turns, and consequently in that case will turn with it, but if the screws be released, the telescope will turn without it.

*NOPQ* is a brass frame, the two ends of which, *ON*, *PQ*, consist of two pieces, one of which goes over the arc *LM*, and the other under, so that by means of two screws at *y* and *x* to press them together, the frame may be fixed to the arc, in which case the screw *cd*, passing through a nut at *s* on the arm *K*, will move the vernier *vw*; *V* is a brass circle graduated on the edge, and moveable with the screw *cd*, against which is fixed a piece of brass *r* as an index; *W* is a piece of brass fixed on an immoveable piece of wood, on which is another piece not seen to receive the end of the axis *B*, and in which it turns, and this piece is moveable east or west by a screw of adjustment; the end turns in a brass socket *e f*, moveable by a screw *T* in order to alter the inclination of the axis *AB*, and thence adjust it to the latitude; *RS* is an equatorial circle fixed perpendicular to *AB*, having a vernier *mn*; this circle is divided into 24 hours, and each hour into minutes, and the vernier subdivides into seconds.

The adjustments are three; first, to set *AB* parallel to the earth's axis; secondly, to adjust the line of collimation parallel to the circle *HI*; thirdly, to adjust the cross axis perpendicular to the polar axis. The first adjustment consists of two parts, to set the axis at the proper angle, and to place it in the plane of the meridian. Now to adjust the axis to an angle equal to the latitude of the place, the instrument is supposed to be at first fixed as nearly as possible to the true angle, and then the error is to be corrected by adjustment; to do which, turn about the polar axis until the circle *HI* becomes perpendicular to the horizon, and direct the horizontal wire of the telescope to the pole star, or any other whose polar distance is known, when it comes above or below the pole; then turn the axis half round (which is shewn on the equatorial circle); in which case the circle becomes perpendicular to the horizon again; then if the axis be at the proper angle, it is manifest that the telescope is now directed to a point as much below or above the pole as it was above or below before, that is, to the polar distance of the star increased or diminished by the refraction of the star at the first observation; hence, if we turn the telescope till the star be again observed at the same wire, the indices *a, b*, will have moved over twice the refraction, supposing the star to be so near to the pole, that the refraction may be considered the same both above and below; for if the star be first observed above, its apparent place is above the true, and therefore if the telescope and star revolve about the axis till they come below, the telescope is now directed to a point below the true place by the refraction, and as the apparent place is now above the true place by refraction, the telescope is directed to a point distant from the apparent place of the star by twice the refraction; but if it do not move over twice that distance, then half the difference is the error of the angle of the elevation of the axis; move the telescope therefore through twice the distance which the indices *a* or *b* will shew, then turn the telescope, and bring it half way to the star, and by the screw *T* bring the star to the wire, and the axis is adjusted to an angle equal to the latitude of the place; in the same manner we determine whether the axis be in the plane of the meridian, by observing the star in the equator, either in the east or west, and then turning the axis half round, if the axis be rightly adjusted to the meridian, the telescope must be moved  $180^\circ$  in order to bring the star to the same wire; hence if the telescope do describe  $180^\circ$  the axis is right; if not, half the difference is the error; move, therefore, the telescope through  $180^\circ$ , and then by turning it bring it half way to the star, and by the screw at top out of sight bring

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bring it the other half, and the polar axis is truly adjusted. Secondly, to adjust the line of collimation parallel to the circle  $H I$ . Observe a star in the equator, and note the time of its transit over the middle wire of the telescope by a clock, adjust it to sidereal time, and note also the time shewn by the vernier  $m n$  on the hour circle  $R S$ ; turn the polar axis half way round according to the order of the figures on the hour circle  $R S$ , and the vernier shews a difference of 12 hours; now as the line of collimation is first directed to the equator, it must be perpendicular to the polar axis, and therefore by turning the polar axis about, it must continue to be directed to the equator, whether or not it be parallel to the plane of the circle  $H I$ ; and if this could be done, and the telescope turned about, and the observation repeated without loss of time, the star would appear on the same wire, provided the line of collimation were parallel to the plane of the circle  $H I$ , for then the line of collimation in the second observation being parallel to what it was in the first, it must be directed to the same point in the heavens, the telescope being turned half round; but as this operation will take up some time, the polar axis must be turned a little more than half round in order to bring the star to the same wire, and the vernier would point out the same difference of times as the clock shews in the interval of the observations; but if these differences of times shewn by the clock and the hour circle be not equal, the line of collimation is not parallel to the plane of the circle, and half that inequality of times is the error, which must be corrected by the adjustment for that purpose. Thirdly, to adjust the cross axis perpendicular to the polar axis, or to the line of collimation. By the last adjustment, the line of collimation was made to move in a plane; therefore, if that plane be adjusted to the polar axis, the line of collimation will describe a secondary to the equator. On this supposition, if we take a star of any declination, and note the time of its transit over the middle wire by the clock, and also the hour on the hour circle; then turn the polar axis half round, and observe again as in the last position, and the differences of the times of the two observations shewn by the clock, and on the hour circle diminished by 12, must be equal; but if the line of collimation do not describe a secondary, the differences will not be equal. To correct, therefore, this error, let  $E Q$ , *fig. 2. Plate XVII.* be the equator,  $E P Q$  a great circle passing through the pole  $P$ ,  $E F Q$  the great circle described by the line of collimation, and let the telescope be directed to a star  $z b$ , and let  $d b y$  be a portion of its parallel, take  $a d = a b$ , and draw the secondaries  $P d m$ ,  $P b c$ . Now it is manifest, that if we turn the polar axis half round, the plane  $E F Q$  will then lie as much on the contrary side of  $E P Q$ ; and, therefore, when the telescope is directed to the star's parallel, it will cut it at  $d$ , and half  $m C$ , or  $E c$ , is the error of right ascension. Note the time on the hour circle, and continue to turn (in the present instance) the polar axis until the star, now at  $x$ , on account of its motion, be again brought to the middle wire, and note again the time on the hour circle, and we have the difference  $m r$  shewn by the hour circle, from which subtract the time  $c r$ , shewn by the clock between the observations, and we have  $m C$ , the half of which is  $E c$ . Now the star being on the middle wire, move the polar axis so as to cause the hour circle to move through an arc  $r s$  equal to  $E c$ , and by the screw  $g$ , *fig. 1.* alter the position of the cross axis, and consequently of the plane  $E F Q$  till the star appears again on the same wire, moving, if necessary, the telescope on the circle  $H I$  to bring the star into the field; and then as  $y x = a b$ , the line of collimation would have been corrected so as to make it pass through  $P$ ,

and the adjustment would have been truly made, provided the star had not moved in the time of this last operation. Correct again, therefore, and you will get the line of collimation to describe a secondary to the equator, when the telescope is moved on the circle  $H I$ . Thus the instrument is adjusted for use.

*To find any object in the heavens, whose right ascension and declination are known.*—Find its distance, at the time required, from the meridian in the usual way, and reduce it to sidereal time, and turn about the polar axis, that way the object lies from the meridian, until the hour circle points out that distance of the telescope from it; then turn the telescope till the indices  $a, b$ , shew the polar distance, and the object will be in the field of view. By this means we direct the telescope to a comet, or any other body whose place is known, which is invisible to the naked eye.

*To find the true place of a body, and trace out its path in the heavens.*—Screw the index  $K$  to the cross axis of the telescope; bring the body upon the wire parallel to the equator, and take the time of its transit over the middle wire perpendicular to it, and note the degrees on the arc  $L M$ , pointed out by the vernier  $v w$ ; then if there be any known fixed star near its parallel, move the telescope on the circle  $H I$  (the polar axis remaining fixed) to the star's parallel, wait till the star enters the field of view, and make it run along the same wire as the body did, and take the time of its transit at the middle wire, and the difference of these times will give the difference of their right ascensions, and the difference of the arcs on  $L M$ , pointed out by the vernier  $v w$  at the times of the transits, gives the difference of their declinations; hence the right ascension and declination of the body is known. Continue these observations as long as the body is visible, and you will get its path in the heavens. The utility and convenience of this method is, that we can at any time determine the place of a body without waiting for its coming to the meridian; where, besides the inconvenience of waiting, an observation might be hindered by the badness of the weather, or the body might come to the meridian in the day-time, when it could not be seen.

An instrument, somewhat similar in construction, but with considerable improvements, was begun by Mr. Bird in the last year of his life, or the year preceding, for the observatory at Oxford, and was finished by Mr. Troughton (the senior) about the year 1773, by order of Mr. Bird's executors. We regret that we have not had the means, in due time, of obtaining a perspective drawing of this instrument, that we might have gratified our readers with a description of it.

*EQUATORIAL Stand* of a telescope is a contrivance for making a common telescope follow a celestial body in its apparent path along, or parallel to, the equator; and answers the purpose of a polar axis of motion, while it adds but little to the expence of a simple stand for horizontal and vertical motions only. The thing required to be done to a common stand, was to give the horizontal motion an equatorial direction, and then the vertical motion, of itself, becomes a motion in declination, or in an horary circle, as well out of, as in the meridian. Various methods have been devised of effecting this purpose in the simplest way; but the contrivance invented by Mr. Smeaton, usually called *Smeaton's Block*, and which has all the advantages of cheapness, stability and simplicity, has been preferred to all others, and in our opinion merits a place in our collection of astronomical instruments.

*Fig. 5. of Plate XIII. of Astron. Infl.* is a representation of an equatorial stand of Smeaton's construction, in which  
the

the three legs are of mahogany, well braced together, and shortened at the lower extremities for the purpose of bringing them within the plate. The part *ab*, at the top of the legs, in the shape of a blunt wedge, is of mahogany, and is fast to the legs; the other similar part *cd*, above it, is also mahogany, and sloped exactly like the part *ab*; the two parts taken together are called the *block*, the lower half of which is fixed, and the upper moveable on a strong cylindrical piece of brass fixed to the piece *cd*, at right angles to the line of section, or plane of contact, and passing through the piece *ab* so as to be fixed, when necessary, by a finger screw below the block, and within the junction of the three legs. The plane of contact of the two halves of the block is so sloped as to make an angle exactly equal to one half of the co-latitude of the place of observation, with a horizontal line, in which the under-face of the block is supposed to be by its position; but as the upper half of the block is exactly similar to the under one, its face, when in the present equatorial position, makes an angle with the horizon equal to the whole co-latitude of the place; *i. e.* when in the meridian, is coincident with the plane of the equator. When the part *cd* is turned half round, so that the point *d* may coincide with the point *a*, and the point *c* with the point *b*, the slopes of the two halves of the block are then reversed, and the face of *cd* becomes horizontal: hence it appears that a motion of the half block *cd* round its axis of motion, will carry any telescope *g*, or other body, placed on it parallel to its face, in the direction of the equator, provided it be placed in the meridian of the place when it has the greatest elevation. Accordingly an axis of motion of a small graduated equatorial circle *e* is attached perpendicularly to the face of the half block *cd*, round which the said circle is moveable; and over this circle is mounted a graduated semicircle of declination *f*, or of altitudes, when the block is in its horizontal position, to which the telescope is made fast. The circle *e* is divided into half degrees, or two minutes of time, and is subdivided by a vernier into  $\frac{1}{10}$ th of this quantity, that is, into minutes of space, and four seconds of time; the declination-semicircle is also subdivided into minutes of space by a vernier; and by enlarging the radii the subdivisions might be rendered still more minute; but the use of these graduations is merely to find a star or planet, by its right ascension and declination, to which purpose the instrument is quite competent. Mr. Troughton informs us, that he has made this stand an universal one sometimes, by dividing the block diagonally by an angle of  $45^\circ$ , in which case it would take any degree of elevation from a horizontal to a vertical position, and one of the half blocks, being graduated into  $360^\circ$ , was read by a vernier fixed to the other, so as to ascertain any given quantity of elevation; but as the construction of the instrument does not admit of great accuracy in its adjustments and motions, he considered such addition rather as curious than really useful in astronomy. Still, however, when the telescope is fitted up with the best micrometer for measuring the difference of right ascensions and declinations, and when the stand is made very steady, the instrument may be very serviceable in an observatory, and is often made a part of its furniture.

The sliding tubes *h* are sometimes superadded to brace the eye-end of the telescope, and are found to answer a good purpose, when well made, and fitted to any pair of the legs that may happen to be turned towards this end of the telescope. Both the equatorial circle *e* and semicircle *f* have the usual apparatus for quick or slow motion; and when the block is in the horizontal position, the telescope may be fixed, by the finger screw under the block, to be conveniently used for viewing terrestrial objects; in which posi-

tion the instrument makes no contemptible theodolite, as well as equal-altitude instrument, when a level is added.

**EQUEA**, in *Geography*, a town of Africa, on the Gold coast.

**EQUERY**, or **ECURY**, a grand stable or lodge for horses, furnished with all the conveniences thereof; as stalls, manger, rack, &c.

The word is formed from the French, *escurie*, which signifies the same thing. Some again derive *escurie* from the Latin, *scuria*, which not only denotes a place for beasts to be put up in, but also a grange or barn. But a more probable derivation is from *equile*, a stable for horses, of *equus*, horse.

Some hold that the word stable, in propriety, relates only to bullocks, cows, sheep, hogs, &c. and equery, to horses, mules, &c.

A simple equery is that provided for one row of horses; a double equery that provided for two, with a passage in the middle, or two passages; the horses being placed head to head, as in the little equery at Versailles.

Under equery are sometimes also comprehended the lodgings and apartments of the equeries, grooms, pages, &c.

**EQUERY**, *escuyer*, is also an officer who has the care and management of the horses of a king or prince.

**EQUERIES**, or **EQUERRIES**, popularly called *querries*, are particularly used amongst us for offices of the king's stables, under the master of the horse, five in number, who, when his majesty goes abroad, ride in the leading-coach, are in waiting, one at a time, monthly, and have a table with the gentlemen-ushers during the time, and a salary of 300*l.* a-year each: that of the first equerry and clerk-martial being 500*l.*

They used to ride on horseback by the coach side when the king travelled: but that being more expensive to them than necessary to the sovereign, it has been discontinued.

**EQUERIES of the crown stable**, have that appellation, as being employed in managing and breaking the saddle-horses, and preparing them for the king's riding.

The equerry of the crown stable has an annual salary of 200*l.* and is, or always should be, in close waiting at court; and when his majesty rides holds the stirrup, while the master of the horse, or one of the equeries in his absence, assists in mounting him; and when his majesty rides, they usually attend him. To the establishment of the queen's household belong two equeries with a salary of 220*l.* each. There are also two belonging to the prince of Wales's household. Officers under the same denomination form a part of the established households of the royal dukes, &c.

**EQUES AURATUS**, is used to signify a knight bachelor, called *auratus*, *q. d. gilt*, because anciently none but knights might gilt or beautify their armour, or other habiliments of war, with gold.

In law this term is not used, but instead of it *miles*, and sometimes *chevalier*.

**EQUESTRIA**, among the Romans, a place in the theatre where the equites or knights sat.

**EQUESTRIS**, **EQUESTRIAN**, formed of the Latin, *equus*, knight, horseman, of *equus*, horse, a term chiefly used in the phrase equestrian statue, which signifies a statue representing a person mounted on horseback.

The Fortuna equestris, in ancient Rome, was a statue of the goddess on horseback. We sometimes also say, *equestrian column*, which see.

**EQUESTRIAN cohort**, in *Antiquity*. See **COHORS equitata**.

**EQUESTRIAN games**, *ludi equestres*, among the Romans, horse-races, of which there were five kinds, the prodromus,

or plain horse-race, the chariot race, the decurfory race, about funeral piles, the ludi fevirales, and the ludi neptunales.

EQUESTRIAN order, among the Romans, signified the order of the knights or equites.

EQUI, in *Ancient Geography*, a small town of Africa Propria, near a lake in the vicinity of Utica. According to Diodorus Siculus it was taken by Agathocles.

EQUIANGULAR, in *Geometry*, is applied to figures whose angles are all equal; such are the square, and all regular figures.

All equilateral triangles are also equiangular.

An equilateral figure inscribed in a circle is always equiangular; but an equiangular figure inscribed in a circle is not always equilateral, except when it has an odd number of sides. If the number of the sides be even, then they may be either all equal, or else half of them will always be equal to each other, and the other half to each other; the equals being placed alternately. See Hutton's *Math. Misc.* p. 272.

EQUIANGULAR is also applied to any two figures of the same kind, when each angle of the one is equal to a corresponding angle in the other, whether each figure, separately considered, be an equiangular figure or not, that is, having all its angles equal to each other. Thus, two triangles are equiangular to each other, if, *e. g.* one angle in each be of  $30^\circ$ , a second angle in each of  $50^\circ$ , and the third angle of each equal to  $100^\circ$ .

Equiangular triangles have not their like sides necessarily equal, but proportional to each other; and such triangles are always similar to each other.

EQUICRURAL TRIANGLE, is what we more usually call an isosceles triangle.

EQUICULUS, EQUULEUS, or *Equus minor*, in *Astronomy*, a constellation of the northern hemisphere. See EQUULEUS.

EQUIDIFFERENT, in *Arithmetic*. If in a series of three quantities there be the same difference between the first and second as between the second and third, they are said to be continually equidifferent; but, if in a series of four quantities, there be the same difference between the first and second as between the third and fourth, they are said to be discretely equidifferent.

Thus, 3, 6, 7, and 10, are discretely equidifferent, and 3, 6, and 9, continually equidifferent.

EQUIDISTANT, in *Geometry*, a term of relation between two things which are every where at an equal or the same distance from each other. Thus, parallel lines are said to be equidistant, as they neither approach nor recede.

EQUILATERAL, of *æquus*, equal, and *latus*, side, is applied to any figure whose sides are all equal. Thus, an equilateral triangle is that whose sides are of equal length. In an equilateral triangle all the angles are likewise equal. See EQUIANGULAR.

All regular polygons and regular bodies are equilateral. See POLYGON, REGULAR, &c.

EQUILATERAL Hyperbola, is that in which the conjugate axes, and every pair of conjugate diameters, are equal to each other. The asymptotes are also at right angles to each other, and each of them forms a right angle with the axis. Such an hyperbola is also equal to its opposite hyperbola, and likewise to its conjugate hyperbola, so that all the four conjugate hyperbolas are mutually equal to each other.

Hence, as the parameter is a third proportional to the

conjugate axes, they are all mutually equal; consequently,

if in the equation for the hyperbola  $y^2 = \frac{p}{t} \times tx + x^2$ , or =

$\frac{c^2}{t^2} \times tx + x^2$ , in which  $t$  is the transverse axis,  $c$  the conjugate,  $p$  the parameter,  $x$  the absciss, and  $y$  the ordinate,  $t$ ,  $c$ , and  $p$  being made equal, the equation for the equilateral hyperbola becomes  $y^2 = tx + x^2$ ; differing from that of the circle merely in the sign of the term  $x^2$ , which in the circle is —. See HYPERBOLA.

EQUILIBRIUM, or EQUIPOISE, in *Mechanics*, means an equality of forces acting in opposite directions, so that they mutually balance each other. Thus, the scales of a balance are said to be in equilibrio, when neither of them preponderates, in consequence of which the beam of the balance remains perfectly horizontal. But, it must not be imagined, that the equality of weights alone determines the equilibrium of mechanisms in general; for that is only the case when the velocities and directions are equal, as in the above-mentioned case of the balance, where the two arms of the beam being equal, the weights in the scales have equal velocities, supposing that the balance is made to vibrate, and move in vertical directions. Therefore, it has been said above, that the equilibrium takes place, when the forces, which act in opposite directions, are equal; for the forces are estimated from the weight of the bodies, their velocities, and directions conjointly. Thus, in the common mechanical powers, the equilibrium takes place, when the power is to the weight as the velocity of the weight is to the velocity of the power. The equilibrium of solids forms a considerable part of the science of statics, and the equilibrium of fluids forms a considerable part of hydrostatics.

EQUILIBRIUM is also used figuratively on other occasions. A painter must take care to observe the equilibrium of his figures, *i. e.* dispose them well on their centre of gravity, that they may not seem ill-supported, or ready to tumble. Thus, *e. gr.* if one arm be moved forward, the other must be proportionably backward to poise the figure.

In a picture there should always be an equilibrium between one part and another; that is, the objects are to be distributed so as to balance and contrast each other; and not too many, *e. gr.* be crowded on one side, and the other be left bare.

EQUIMULTIPLE, in *Arithmetic* and *Geometry*, is applied to simple magnitudes when multiplied equally, *i. e.* by equal quantities or multipliers.

Thus, taking A as many times as B, or multiplying them equally, there will still remain the same ratio between the magnitudes thus multiplied, as between the primitive magnitudes before multiplication.

Now those magnitudes, thus equally multiplied, are called equimultiples of the original ones A and B; whence we say, that equimultiples have the same ratio as the simple quantities. In arithmetic, we generally use the term equimultiples for numbers which contain equally or an equal number of times their submultiples.

Thus 12 and 6 are equimultiples of their submultiples 4 and 2, inasmuch as each of them contains its submultiple three times.

EQUINA SELLA. See SELLA.

EQUINOCTIAL, in *Astronomy*, a great circle of the sphere, under which the equator moves in its diurnal motion.

The equinoctial is conceived by supposing a semidiameter of the sphere produced through a point of the equator, and there, by the rotation of the sphere about its axis, describing a circle on the immoveable surface of the primum mobile.

The

The poles of this circle are the poles of the world. The sphere is divided by it into two equal parts, the northern and southern. It intersects the horizon of any place in the east and west points; and at the meridian its elevation above the horizon is equal to the co-latitude of the place.

Whenever the sun, in his progress through the ecliptic, comes to this circle, it makes equal days and nights all around the globe; as he then rises due east and sets due west, which he never does at any other time of the year. And hence the denomination from *æquus* and *nox*, night, *quia æquat diem nocti*. All the stars that are under this circle, or that have no declination, do also rise due east and set due west.

The equinoctial, then, is the circle which the sun describes, or appears to describe, at the time of the equinoxes: that is, when the length of the day is every where equal to that of night, which happens twice a year. (See EQUINOX.) From this circle is the declination in the heavens or latitude of places on the earth counted in degrees of the meridian. Upon this circle is reckoned the longitude,  $180^{\circ}$  west and  $180^{\circ}$  east, in all  $360^{\circ}$ . Hence,  $1^{\circ}$  of longitude answers to  $4'$  of time;  $15'$  to  $1'$  of time; and  $1'$  to  $4$  seconds of time, &c.

The shadows of those who live under this circle are cast to the southward of them for one-half of the year, and to the northward of them during the other half; and twice in a year, *viz.* at the equinoxes, the sun at noon casts no shadow, being in their zenith.

EQUINOCTIAL *colour*, is that passing through the equinoctial points. See *COLURE*.

EQUINOCTIAL *dial*, is that whose plane lies parallel to the equinoctial. See *DIAL*.

EQUINOCTIAL *hours, line, orient*. See the substantives.

EQUINOCTIAL *points*, are the two points wherein the equator and ecliptic intersect each other: the one, being in the first point of Aries, is called the vernal point, or equinox; and the other, in the first point of Libra, the autumnal point, or equinox.

The equinoctial points, and, indeed, all the other points of the ecliptic, are found, by observation, to be continually moving backwards, or in antecedentia, *i. e.* towards the west. This retrograde motion is called the *Precession of the equinoxes*; which see.

EQUINOX, in *Astronomy*, the time when the sun enters one of the equinoctial points.

The equinoxes happen when the sun is in the equinoctial circle, of consequence the days are equal to the nights throughout the world, which is the case twice a year, *viz.* about the 21st of March, and the 22d of September, the first of which is the vernal, and the second the autumnal equinox.

As the sun's motion is unequal, that is, sometimes swifter and sometimes slower (from the causes already explained under the article *EQUATION*), it comes to pass, that there are about eight days more from the vernal to the autumnal equinox than from the autumnal to the vernal, the sun spending so much more time in travelling through the northern than the southern signs.

According to the observations of M. Cassini, the sun is  $186^{\text{d}} 14^{\text{h}} 53'$  in the northern signs, and only  $178^{\text{d}} 14^{\text{h}} 56'$  in the southern. The difference of which is  $7^{\text{d}} 23^{\text{h}} 57'$ .

The sun, continually advancing forwards in the ecliptic and gaining a degree every day, makes no stay in the equinoctial points, but the moment he arrives in them he also leaves them.

Of course, therefore, though the day the sun enters the

equinoctial point is called the equinox,  $\ast$  being reputed equal to the night; yet it is not precisely so, unless the sun enter the equator at mid-day: for if the sun rising, should enter the vernal equinox at setting, he will have departed from it, and have got northwards about  $12'$ ; consequently, that day will be somewhat longer than 12 hours, and the night proportionably shorter.

The time of the equinoxes, *i. e.* the moment in which the sun enters the equator, is found by observation, the latitude of the place of the observation being given.

Thus, in the equinoctial day, or near it, take the just meridian altitude of the sun; if this be equal to the altitude of the equator, or the complement of the latitude, the sun is that very moment in the equator: if it be not equal, the difference is the sun's declination. The next day observe the meridian altitude as before, and find his declination; if the declination be of different kinds, *viz.* the one north and the other south, the equinox has happened in the interval of time between them; otherwise, the sun has not entered the equinoctial, or had passed it at first. From these observations a trigonometrical calculus gives the time of the equinox.

Thus, let DG (*Plate XII. Astronomy, fig. 110.*) represent the equator, AC the ecliptic, E the equinoctial point; the points A, B, C, the places of the sun at the times of observation; the arcs AD, BE, CG, the corresponding declinations; in the right-angled spherical triangles CEG, BEF, the obliquity of the ecliptic, and the declinations are known; whence may easily be found EC, EB; then BC, the sum or difference of EC, EB is the ecliptic arc described in 24 hours: then say as BC : BE :: 24 hours for BC : time for BE; and this time shews the distance of the equinox from the time of the middle observation.

EQUINUS BARBATUS, a kind of comet. See *HIPPEUS*.

EQUINUS *ellipticus* and *quadrangularis*. See *HIPPEUS*.

EQUINUS *venter*. See *VENTER equi*.

EQUIP, *To*, in *Naval Language*, a term borrowed from the French marine, and frequently applied to the business of fitting a ship for sea, or arming her for war. See *FITTING-OUT*.

EQUIPAGE, in *Navigation*. See *CREW* and *FITTING-OUT*.

EQUIPAGE, *Camp*. Under this term we confine ourselves entirely to what relates to the tents generally in use; remarking, that such as suit admirably for a cold climate, would be found totally unserviceable in higher latitudes, where the air, confined in a small space, under a vertical sun, while probably not a leaf is in motion, could not fail to be unfit for respiration. Therefore, we shall give the regulation sizes of tents, both according to the home service, and to what is found necessary for troops employed in the East Indies.

*Home Service, Laboratory Tent*, with mallets, poles, pins, &c. should weigh 3 cwt. 24 lb.; and ought to be sustained on poles of  $14\frac{1}{2}$  feet each in length; the ridge pole should be 18 feet. Some of these are made with half-walls; that is, their flies, or canopies, do not come within three feet of the ground, but are there fastened to a half-wall, or curtain, which being laced or hooked to the interior of the fly, hangs perpendicularly to the ground, to which it is secured by wooden pins, or pegs.

*India Service, Laboratory Tent*.—This class of tents is nearly similar, but they have commonly extra flies, standing at about a yard distant from the inner shell, which are sometimes

well soaked in oil, or slightly with tar, at least sufficiently to throw off rain. This occasions them to be extremely ponderous; the poles being some feet longer, and the spread of canvas considerably greater; the average weight of a laboratory tent may here be taken at nearly half a ton. Such a weight could only be conveyed on an elephant, or on a cart, (the latter being far too dilatory for most situations,) were it not that the fly, the shell, and the walls, are all made to separate. By this means two camels may conveniently bear one of these tents.

*Home Service, Bell Tent*, should, according to the new construction, have a pole of 9 feet long, and form a circular spread of 14 feet in diameter, so as to give shelter to twelve men. Since it has been found necessary to reduce the quantity of baggage attached to our armies, little or no use is made of any tents that are inadequate to the shelter of a certain number of persons; consequently those bell tents, which were called "Bells of Arms," have in a manner ceased to be known in our arsenals, they being totally incompetent to any essential service. The modern bell tent is, therefore, to be considered as a medium between the bells of arms, and the private tents formerly in use; they are extremely portable, and, in proportion to their weight, which ought not to exceed 45 lb. are far more serviceable; as they cover twelve men better than the common infantry tents, that weighed 27 lb., did five. The facility with which a tent, having only a pole, is raised, or struck, the great safety it insures from presenting no flat side to the wind, and the paucity of pins, &c. requisite for its use, give it a very considerable claim to preference.

*Indian Service, Bell Tents*, are made of very stout canvas, supported on poles of about 7 feet in length, and overlapping in their front, for the purpose of keeping the arms they contain perfectly dry. The musquets, &c. are filed round the pole of a bell tent by means of two sticks, about 18 inches in length, passing at right angles to each other, and to the pole also, through two holes made in the latter. These, which may be drawn at pleasure, form a cross, in the four divisions of which the arms of the company are filed. Average weight, when dry, 1 cwt.; when wet, 1 cwt. 1 qr. 14 lb.

*Home Service, Common Infantry (or Private) Tents*, which are now less used than formerly, require two standard poles, each 6 feet in length, and a ridge pole of 7 feet. They should weigh *in toto* 27 lb., and be capable of covering five men. It is obvious, that a tent of this description must be less safe, and less comfortable to its inhabitants, than the bell tent now substituted.

*Indian Service, Private Tents*, stand upon two poles, each 9 feet long, and have a ridge pole of 8 feet. These tents are made of very strong canvas, and are sometimes lined separately; whereby they are rendered tolerably cool. They should be capable of sheltering twelve men commodiously; but in hot weather not more than eight ought to be allotted to one tent. Considerable relief is afforded by the walls of these tents; which are generally about 30 inches high. The average weight of one, complete, may be about 2 cwt. 1 qr. when dry; but when wet, it will perhaps exceed 4 cwt.

*Home Service, Officer's Marquee*, should have two standard poles, each 8 feet high, and a ridge pole of 7 feet: the total weight about 130 lb. This kind of tent has walls about 4 feet in height, and is generally furnished with a separate lining throughout.

*Indian Service, Marquees*, are upon a very different construction. The proportions are as follows; *viz.*

	Length.	Breadth.	Ridge Poles.	Standard Poles.
Captain's marquee on two poles lined throughout with gingham, and having walls of 5 ft. 6 in.	23 feet.	15 feet.	10 feet.	12 feet.
Subaltern's tent on 1 pole	14 feet.	14 feet.	—	11 feet.

These proportions may seem very great, but they are found to be actually necessary in that climate. The total weight of a captain's marquee may be estimated, when dry, at 4 cwt.; when wet, at 6½ cwt. A subaltern's marquee, when dry, 3½ cwt.; and when wet, 5 cwt.

With respect to the larger classes of tents, such as are used by our colonels and general officers, they approach somewhat towards the construction of what, in the Indian service, are called field officers' sleeping tents, which generally have from 12 to 14 feet between two poles of 14 feet in height. They are chiefly composed of strong shells made of Russia-duck, with flies of canvas, and are ordinarily lined with perpet. The weight of such a tent may be computed at 5 cwt. when dry; and when wet at 7½ cwt. State tents may measure about 18 feet in the ridge, and have standards of full 16 feet in height. Their poles are generally made in two pieces, joining in their centres by means of a cylinder of iron; on the same principle as the sliding ferrils in ladies' parasols.

We have thus given some insight into the proportions between the tents appropriated to the several classes, so far as they could tend to instruct the reader; who will, of course, understand, that in proportion as the standards of a tent are lengthened, so will the several slopes of the fly be lengthened in a suitable ratio. The ordinary computation is, that the direct depth of the slope ought to be two-thirds the length of the poles where a full wall is to be attached; four-fifths where a half-wall is to be furnished; and that the pole should be one-quarter, or even a third, less in length than the direct slope of the fly is deep, if no walls whatever are to be added. The climate will indicate the necessity for more or less steepness in the slope; for if little rain falls, less declivity will answer; whereas, if, as in India, the rains are abundant and heavy, such a slope must be given as may insure that the interior should remain dry.

It is of the utmost importance, that all camp equipage should be made not only conformably to a particular pattern, thereby to preserve uniformity of appearance; but, as nearly as practicable, of the same kind of materials, and of a given weight; so that a very correct estimate may be formed both of the bulk and gravity of the whole, when about to be conveyed either by land or by water. Besides, it is expedient, that the camp-colourmen, batmen, &c. should have a perfect understanding of this branch of military economy, and have the whole of the tents handed to them, when about to be laden, or conveyed, packed in a regular manner; so as to occupy as little space as possible; otherwise they never can flow to advantage, so as to be safe, and to afford as much space as can be spared for other articles.

**EQUIPAGE**, in the *Military Art*, denotes all sorts of utensils, artillery, &c. necessary for commencing and prosecuting with ease and success any military operations.

**EQUIPOLLENCE**, in *Logic*, is when there is an equivalence between any two or more terms or propositions; *i. e.* when they signify one and the same thing, though they express it differently. Such propositions, &c. are said to be equipollent.

**EQUIPPE'**, in *Heraldry*, expresses a cavalier equipped, *i. e.* armed at all points.

**EQUIRIA**, in *Antiquity*, a festival instituted by Romulus, and celebrated on the 27th of February, in honour of Mars, at which there were horse-races.

**EQUISELIS**, in *Natural History*, the name of a large fly, of the size of a hornet, but having only two wings and no sting: it otherwise much resembles the common hornet in shape. This fly is found only in Macedonia. We have also in England flies which nearly resemble the hornet, wasp, and bee, but in their wanting stings and having only two wings.

**EQUISELIS**, in *Ichthyology*, a name used by some authors for a sea-fish, caught on the Spanish shores, and supposed by many to be the same with the *Dorado*, or *Coryphæna*, with the forked tail of Artedi. See *CORYPHÆNA*.

**EQUISETUM**, in *Botany*, from *equus*, a horse, and *feta*, a strong hair or brittle. Horsetail. Plin. Hist. Nat. lib. 26. cap. 13. Linn. Gen. 559. Schreb. 753. Mart. Mill. Dict. v. 2. Sm. Fl. Brit. 1102. Hedwig. Theor. 33. t. 1, 2. Juss. 17. Class and order, *Cryptogamia Filices*. Linn. *Cryptogamia Miscellaneæ*. Schreb. Nat. Ord. *Filices spicate*.

Gen. Ch. *Fruifications* in an ovate-oblong terminal catkin, composed of whorled, stalked scales. Each scale peltate, somewhat orbicular, but with many sides, bearing on its under side from four to seven tubular, angular, obtuse sheaths, parallel to and surrounding the stalk of two valves, bursting internally, containing numerous florets. *Stam.* Filaments four, coiled up round the germen, in a spiral manner, while moist, divaricated when dry; anthers terminal, simple, spatulate. *Pist.* Germen globose, wrapped up in the stamens; style none; stigma obsolete, acute. *Seeds* globose, deciduous, accompanied by the stamens.

Ess. Ch. Catkin with peltate scales, fructifying on their inside. Partial involucrems tubular, of two valves. Seeds numerous, naked, surrounded by four spiral stamens.

Many different opinions have existed concerning the fructification of this genus, but Hedwig's, as above given, seems to us the most satisfactory. In the artificial classification we retain it among the ferns, to which it is closely allied in natural affinity, though of itself a most natural and distinct genus; nor do we think Schreber's order, entitled *Miscellaneæ*, lessens in any degree the difficulties respecting this tribe.

Seven species of *Equisetum* are found in Britain, and two or three foreign ones are imperfectly known besides.

*E. sylvaticum*, Engl. Bot. t. 1874, known by its compound drooping branches, is one of the prettiest. It occurs chiefly in mountainous countries, in moist, shady spots.

*E. hyemale*, Engl. Bot. t. 915, called Shave-grass or Dutch rush, is remarkable for the callous roughness of the ribs of its naked stem, which renders it useful in polishing wood, ivory, and even brass. Being rare in England, it has for these purposes been imported from Holland. Professor Davy has detected a large proportion of stinty earth in the cuticle, to which its hardness and asperity are owing.

*E. variegatum*, Engl. Bot. t. 1987, found on the sandy-sea-coast of Scotland, by Mr. G. Don, and a native also of Sweden, Denmark, Switzerland, &c. is a smaller species, nearly related to the last, and having a similar roughness.

*Equiserum*, in *Natural History*, is the name by which some writers have denominated certain fossil plants, (*phytolithii*), which are found bearing some faint resemblance to the recent plant called horse-tail. Mr. William Mar-

tin, after describing an organic remain of this kind in his "*Petrificata Derbienia*," says, "there are other plants with stellate leaves, to which it might with as much propriety be referred: *hippuris*, *asperiala*, and *galium*, for instance," and he continues, "we may here observe, that little has yet been done with respect to discriminating the original genera of fossil plants: those parts indeed, on which such discrimination *must* be founded, are rarely, if ever, visible in the petrified state. The characteristic distinctions of the species are frequently attainable, if studiously sought after, by a diligent and careful comparison of various specimens; and the habit or general appearance of the fossil often leads to the knowledge of the natural class and order of the recent plant: but its genus, for the most part, remains undetermined or doubtful." The great importance of the organic remains or *reliquia* in tracing and identifying the strata, according to the new discoveries of Mr. Smith and his pupils, will, it is hoped, ere long, induce naturalists seriously to turn their attention to this neglected branch of science.

**EQUISONANCE**, in *Music*, a name by which the ancients distinguished octaves from other concords. Octaves being the only *paraphoni*, or concords, when doubled above or below. This is a distinction which would be as useful in modern music as in the ancient. All other concords, doubled, become discords.

**EQUITANTIA, FOLIA**, in *Botany*, is applied to leaves so folded at the base, as to embrace each other in two ranks. See *LEAF*.

**EQUITATA COHORIS**, in *Antiquity*. See *COHORIS Equitata*.

**EQUITY, ÆQUITAS**, denotes justice or right, mitigated and tempered by the consideration of particular circumstances; or a correction and abatement of the severity of some law; or a temperament, which, without being unjust, abates the rigour of some just law.

Equity, as Grotius defines it, is the correction of that, wherein the law (by reason of its universality) is deficient. For since in law all cases cannot be foreseen or expressed, it is necessary, that when the general decrees of the law come to be applied to particular cases, there should be somewhere a power vested of defining those circumstances, which (had they been foreseen) the legislator himself would have expressed. And these are the cases which, according to Grotius, "*lex non exactè definit, sed arbitrio boni viri permittit.*"

This is what the Greeks call *επιεικειη*. The utmost severity of a good law is frequently contrary to justice; it should always have equity for its rule and guide. "*Summum jus, sæpe summa injuria.*"

The foundation of equity is not that there is any mistake in the law, but that the law was laid down universally, because all circumstances could not be considered or taken in under one law.

For an instance, suppose it an express law, that the city being now beset with an enemy, the gates be all shut; and suppose it fall out that the enemy is then in pursuit after some of the citizens by whom it is defended, so that it would be highly prejudicial thereto not to open for them the gates; equity here decrees the gates to be opened, contrary to the express words of the law.

As equity depends, essentially, upon the particular circumstances of each individual case, there can be no established rules and fixed precepts of equity laid down, without destroying its very essence, and reducing it to a positive law. And, on the other hand, the liberty of considering all cases in an equitable light, must not be indulged too

## EQUITY.

far; lest we thereby destroy all law, and leave the decision of every question entirely in the breast of the judge. And law, without equity, though hard and disagreeable, is much more desirable for the public good, than equity without law; which would make every judge a legislator, and introduce infinite confusion, as there would then be almost as many different rules of action laid down in our courts, as there are differences of capacity and sentiment in the human mind.

Equity is of two kinds, and those of contrary effects; the one abridges, and takes from the letter of the law; and the other enlarges, and adds to it.

The first is defined the correction of a law, made generally in that part wherein it fails; as suppose a statute made, "that whosoever does such a thing shall be a felon, or suffer death:" yet if a mad-man, or an infant, who hath no discretion, do the same, he shall neither be a felon nor suffer death.

The other is defined an extension of the words of the law to cases which are not expressed, which yet come under the same reason: so that when one thing is enacted, all other things which are of the like degree are so too.

Thus, the statute which ordains, that in action of debt against executors, he who appears by distress shall answer, extends by equity to administrators; and such of them as shall appear first by distress, shall answer by the equity of the said act, "quia sunt in æquali genere."

EQUITY is also used for the virtue of justice. See JUSTICE.

EQUITY, in our *Laws*, &c. is also frequently used for the COURT of *Chancery*, (which see,) where controversies are supposed to be determined according to the exact rules of equity and conscience, by mitigating the rigour of the common law.

"Æquitas sequitur legem," is an old maxim in law; but, from the great increase of suits in chancery, some have thought fit to give it this construction, that in all cases after a man has been at law, he must go to equity.

Judge Blackstone has given a brief, but comprehensive view of the nature of equity, as it is now understood and practised in our several courts of judicature. Equity, he says, in its true and genuine meaning, is the soul and spirit of all law; *positive* law is construed, and *rational* law is made by it. In this, equity is synonymous to justice: in that, to the true sense and sound interpretation of the rule. But the very terms of a court of *equity*, and a court of *law*, as contrasted to each other, are apt to confound and mislead us; as if the one judged without equity, and the other was not bound by any law. Whereas every definition or illustration to be met with, which now draws a line between the two jurisdictions, by setting law and equity in opposition to each other, will be found either totally erroneous, or erroneous to a certain degree. Thus, in the *first* place, it is said, that it is the business of a court of equity in England to abate the rigour of the common law; but no such power is contended for. The learned judge specifies various cases of positive law, in which the court of equity can give no relief, and in which these, as well as the courts of law, must say with Ulpian, "hoc quidem perquam durum est, sed ita lex scripta est." Again it is said, that a court of equity determines according to the spirit of the rule, and not according to the strictness of the letter: but so also does a court of law. Both, for instance, are equally bound, and equally profess, to interpret statutes according to the true intent of the legislature. In general laws, all cases cannot be foreseen; or, if foreseen, cannot be expressed: some occur that will fall within the mean-

ing, though not within the words of the legislator; and others, which may fall within the letter, may be contrary to his meaning, though not expressly excepted. These cases, thus out of the letter, are often said to be within the equity of an act of parliament; and so cases within the letter are frequently out of the equity. Here by equity we mean nothing but the sound interpretation of the law; though the words of the law itself may be too general, too special, or otherwise inaccurate or defective. These are the cases to which Grotius refers in the passage cited above. But there is not a single rule of interpreting laws, whether equitably or strictly, that is not equally used by the judges in the courts both of law and equity; the construction must in both be the same, or, if they differ, it is only as one court of law may also happen to differ from another, each endeavours to fix and adopt the true sense of the law in question: neither can enlarge, diminish, or alter that sense in a single tittle.

It has been further said, that *fraud*, *accident*, and *trust*, are the proper and peculiar objects of a court of equity. But every kind of *fraud* is equally cognizable, and equally adverted to, in a court of law. Many *accidents* are also supplied in a court of law. And, although a technical *trust*, created by the limitation of a second use, was forced into the courts of equity; and this species of trusts, extended by inference and construction, has ever since remained as a kind of *peculiar* in these courts; yet there are other trusts which are cognizable in a court of law. Moreover, it has been said that a court of equity is not bound by rules or precedents, but acts from the opinion of the judge, founded on the circumstances of every particular case. Whereas the system of our courts of equity is a laboured, connected system, governed by established rules, and bound down by precedents, from which they do not depart, although the reason of some of them may perhaps be liable to objection.

In short, if a court of equity in England did really act, as many ingenious writers have supposed it (from theory) to do, it would rise above all law, either common or statute, and be a most arbitrary legislator in every particular case. Formerly, indeed, our courts of equity arrogated to themselves such an unlimited authority as hath totally been disclaimed by their successors for more than a century past. But the systems of jurisprudence, in our courts, both of law and equity, are now equally artificial systems, founded in the same principles of justice and positive law; but varied by different usages in the forms and mode of their proceedings; the one being originally derived (though much reformed and improved) from the feudal customs, as they prevailed in different ages in the Saxon and Norman judicatures; the other (but with equal improvements) from the imperial and pontifical formularies, introduced by their clerical chancellors.

The suggestion indeed of every bill, to give jurisdiction to the courts of equity (copied from those early times) is, that the complainant hath no remedy at the common law. But he, who should from thence conclude, that no case is judged of in equity, when the law might have given relief, and, at the same time, casts his eye on the extent and variety of the cases in our equity reports, must think the law a dead letter indeed. The rules of property, rules of evidence, and rules of interpretation, in both courts, are, or should be, exactly the same; both ought to adopt the best, or must cease to be courts of justice. Neither a court of equity nor of law can vary men's wills or agreements, or (in other words) make wills or agreements for them. Both are to understand them truly, and therefore both of them uniformly.

uniformly. The rules of decision are in both courts equally apposite to the subjects of which they take cognizance. Such then being the parity of law and reason which governs both species of courts, it may be asked what constitutes their essential difference? It principally consists in the different modes of administering justice in each; in the mode of proof, the mode of trial, and the mode of relief. Upon these, and upon two other accidental grounds of jurisdiction, which were formerly driven into these courts by narrow decisions of the courts of law, *viz.* the true construction of securities for money lent, and the form and effect of a trust or second use; upon these main pillars hath been gradually erected that structure of jurisprudence which prevails in our courts of equity, and is inwardly bottomed upon the same substantial foundations as the whole system of law. As to the mode of proof, when facts, or their leading circumstances, rest only in the knowledge of the party, a court of equity applies itself to his conscience, and purges him upon oath with regard to the truth of the transaction; and, that being once discovered, the judgment is the same in equity as it would have been at law. But, for want of this discovery at law, the courts of equity have acquired a concurrent jurisdiction with every other court in all matters of account. From this compulsive discovery upon oath, the courts of equity have acquired a jurisdiction over all matters of fraud. As to the mode of trial, this is by interrogations administered to the witnesses, upon which their depositions are taken in writing, wherever they happen to reside. With respect to the mode of relief, the want of a more specific remedy, than can be obtained in the courts of law, gives a concurrent jurisdiction to a court of equity in a great variety of cases. Thus it is in executory agreements, and in various kinds of frauds, &c. The true construction of securities for money lent is another fountain of jurisdiction in courts of equity. The form of a trust, or second use, gives the courts of equity an exclusive jurisdiction as to the subject-matter of all settlements and devises in that form, and of all the law terms created in the present complicated mode of conveyancing. This is a very ample source of jurisdiction. Blackst. Com. vol. iii.

*EQUITY of redemption*, on mortgages, is that right which a mortgagor has of redeeming his estate upon payment of the money borrowed. This enables a mortgagor to call on the mortgagee who has possession of his estate to deliver it back, and account for the rents and profits received, on payment of his whole debt and interest; thereby turning the *mortuum* into a kind of *vivum vadium*. But on the other hand, the mortgagee may either compel the sale of the estate in order to get the whole of his money immediately, or else call upon the mortgagor to redeem his estate presently, or, in default thereof, to be for ever foreclosed from redeeming the same, that is, to lose his equity of redemption without possibility of recall. And also in some cases of fraudulent mortgages, (stat. 4 & 5 W. & M. c. 16.) the fraudulent mortgagor forfeits all equity of redemption whatsoever. This is done by proceedings in the court of chancery. But the chancery cannot shorten the time of payment of the mortgage money, where it is limited by express covenant, though it may lengthen it; and then upon non-payment, the practice is to foreclose the equity of redemption of the mortgagor. 2 Vent. 364.

To foreclose the equity, a bill in chancery is exhibited, to which an answer is put in, and a decree being obtained, a master in chancery is to certify what is due for principal, interest, and costs, which are to be prefixed by the decree, whereupon the premises are to be re-conveyed to the mortgagor; or, in default of payment, the mortgagor is order-

ed to be foreclosed from all equity of redemption, and to convey the premises absolutely to the mortgagee. Law of Securities, p. 129. 133.

By stat. 7 Geo. II. cap. 20; after payment or tender by the mortgagor of principal, interest, and costs, the mortgagee can maintain no ejectment, but may be compelled to re-assign his securities.

*EQUITY*, in *Mythology*, sometimes confounded with Justice, a goddess among the Greeks and Romans, represented with a sword in one hand and a balance in the other.

*EQUIVALENT*, is understood of something that is equal in value, force, or effect, to another.

Equivalence is of various kinds, in propositions, in terms, and in things.

*EQUIVALENT propositions*. See *EQUIPOLLENCE*.

*EQUIVALENT terms*, are where several words that differ in sound have yet one and the same signification; as "every body was there," and "nobody was absent," *nihil non*, and *omne*.

*EQUIVALENT things*, are either moral, physical, or statical. Moral, as when we say that the commanding or advising a murder is a guilt equivalent to that of the murderer. Physical, as when a man who has the strength of two men is said to be equivalent to two men. Statical, whereby a less weight becomes of equal force with a greater, by having its distance from the centre increased.

*EQUIVOCAL*, *EQUIVOCUM*; denotes a word or expression that is dubious and ambiguous, or that may have several senses, one true and another false.

Equivalent terms answer to what are otherwise called *homonyma*, or homonymous terms.

Such is the word *emperor*, which is both the name of a dignity, the proper name of a person, and the name of a plant. So also the Latin *gallus*, which stands indifferently for a cock and a Frenchman.

In these cases, one word denotes two or more different ideas, or different sorts of objects; whence that common definition of equivocal in the schools, "quorum nomen est commune ratio vero essentia secundum illud nomen diversa." Philosophers distinguish equivocal into active and passive; or *equivoca æquivocantia*, and *æquivocata*.

*Æquivoca æquivocantia*, or those that denominate and signify things, are words common to several things in a very different signification, *i. e.* to several things which have a similar essence correspondent to the similar denominations. *E. gr.* The word *taurus*, which stands for a sign, a mountain, and an animal; and in one signifies a lowing animal; in another, a heap of stones and earth; and in the third, a constellation or system of stars.

*Æquivoca æquivocata*, or those that are called or denominated, are the things signified by ambiguous names, *e. gr.* a sign, a mountain, and an animal; which last species of equivocal alone Aristotle seems to have had in view in his definition, which agrees to these, and these only.

*EQUIVOCAL action and cause*. See *ACTION* and *CAUSE*.

*EQUIVOCAL generation*, is a method whereby animals and plants are supposed to be produced, not by the usual way of coition between male and female, but by some supposed plastic power or virtue in the sun, &c.

Thus, insects, maggots, flies, spiders, frogs, &c. have usually been supposed to be produced by the heat of the sun warming, agitating, and impregnating the dust, earth, mud, and putrified parts of animals.

This method of generation, which we also call *spontaneous*, was commonly asserted and believed among the ancient philosophers; but the moderns, from more and better observations, unanimously reject it, and hold that all animals,

animals, nay, and vegetables too, are univocally produced; that is, from parent animals, and vegetables of the same species and denomination.

It were a thing, one would imagine, sufficient to discredit the Aristotelian, or rather the Egyptian doctrine of equivocal generation, to find flies, frogs, lice, &c. to be male and female, and accordingly to ingender, lay eggs, &c.

The doctrine of equivocal generation we call an *Egyptian doctrine*, as having, in all probability, had its rise in Egypt, to solve the hypothesis of the original production of men, and other animals, out of the earth, by the help of the sun's heat.

To prove which, the Egyptians, as Diodorus Siculus observes, produce this observation, that about Thebes, when the earth is moistened by the Nile, and afterwards impregnated by the intense heat of the solar rays, an innumerable swarm of mice come forth: whence he infers, that all kinds of animals might equally have arisen out of the earth at the beginning of things; and from these bishop Stillingfleet takes the other writers and adherents to the doctrine of equivocal generation, Mela, Pliny, Ovid, &c. to have borrowed the hypothesis without inquiring into its truth. Derham's *Phys. Theol.* lib. iv. cap. 15. See GENERATION.

**EQUIVOCATION**, *ÆQUIVOCATIO*, the using a term or expression that has a double signification.

Equivocations are expedients to save telling the truth; and yet without telling a falsity. The fathers are great patrons of equivocations and mental reservations, holding, that the use of such shifts and ambiguities is in many cases allowable.

St. Augustine, particularly, is reproached with endeavouring to vindicate Isaac for saving his wife from a crime by an equivocation; "tacuit aliquid veri, & non dixit aliquid falsi." To advance a dubious proposition, knowing it will be understood in a sense different from that you give it in your mind, is an equivocation, and a breach of good faith and sincerity.

In moral theology, it is strictly understood of a term or phrase with two different significations, the common and obvious, the other more unusual and remote; the latter of which being understood by the speaker, but the former by the hearers, they conceive something different from one another.

Of this we have an instance in St. John, chap. xi. where our Saviour is represented as saying, "Lazarus sleepeth," for the disciples who took the word sleeping in the usual signification, concluded that Lazarus, whom they had been told, was sick, began to take rest, and would soon recover; but Jesus, using the word in a less direct and usual signification, meant that Lazarus was dead.

When the equivoque consists of several words, it is properly called an *amphibology*, (which see,) of which we have an instance in St. John, chap. ii. "Destroy this temple," says Jesus, speaking to the Jews, "and I will raise it again in three days."

The lawfulness of the use of equivocations has been greatly disputed among the modern casuists; many grave authors deny that it is allowable to use them on any occasion whatever. Their reason is, that an equivoque is to all intents and purposes the same thing with a lie.

**EQUIVOQUE**, *L'*, in *Music*, is when a sharp, by extreme modulation, becomes a flat, and *à contra*. As the chord of D♯ becoming the chord of C♯ with a sharp 3d, &c. See MODULATION, and EXTRANEOUS.

**EQUULEUS**, or **ECULEUS**, in *Antiquity*, a kind of

rack, or engine of torture, used for extorting the truth; at first chiefly on slaves, but afterwards turned against the Christians.

The patient's arms and legs being fastened on the equuleus with cords, he was hoisted aloft, and extended in such manner that all his bones were dislocated. In this state, red-hot plates were applied to his body, and he was also goaded in the sides with an iron-forked instrument, called *ungula*.

The equuleus was of wood, and had holes at certain distances, with a screw, by which the criminal was stretched to the third, sometimes to the fourth or the fifth hole: at intervals, the screw was slackened again, by which he had some respite; but then he was tormented with questions.

The equuleus in more ancient times was constructed in the form of a horse; the criminal was laid on his back, and his arms were turned under the breast of the equuleus, his hands were bound, and his feet stretched out towards his tail. A rope fastened to the feet was made to pass over a smaller pulley between the hind-legs of the equuleus, and made to coil over another larger pulley fixed under the belly by means of a handle, which the executioner turned round till all the bones, &c. were dislocated. See a learned dissertation on the form and use of this instrument, by Dr. Ward, in the *Phil. Transf.* vol. viii. part iv. p. 32, &c.

Hieronimus Magius, when a prisoner among the Turks, wrote an express treatise "De Equuleo;" and another of Bells, merely as it is said from his memory, without any assistance of books. Sigonius had another treatise on the same subject.

**EQUULEUS**, *Equiculus*, and *Equus minor*, *equi scētio*, the *Horse's Head*, in *Astronomy*, a constellation of the northern hemisphere, whose stars in Ptolemy's Catalogue are 4, in Tycho's 4, in Hevelius's 6, and in Mr. Flamsteed's 10. See CONSTELLATION.

**EQUULEUS**, in *Arts and Manufactures*. See HORSE.

**EQUUS**, in *Zoology*, a genus of the *Belluæ* order. The fore-teeth in the upper jaw are six, erect, and parallel; the lower six, and more prominent; tusks solitary, included, remote; teats two, inguinal.

#### Species.

**CABALLUS**. Tail with long flowing hair. *Equus cauda undique setosa*, Linn. *Equus auricularis brevibus erectis, juba longa*, Briss. *ἵππος*. Aristot. *Ælian*, &c. *Equus, equa, equiferus*, Pliny. *Gesn. Aldr. &c. Cheval*, Buff. *Ross*, *Gesn. Horse*.

**FERUS**. α. *equus ferus*, Hasselq. *Wilde Pferde*, Gmel. Pallas. *Tarpany*, Rytfschk. Orenb. *Wild horses*, Bell.

**DOMESTICUS**. β. *equus domesticus*. *Domestic horse*.

This generous animal is cultivated in most parts of the earth, and is found in a wild state in the deserts of Great Tartary, in the southern parts of Siberia, the banks of the river Don, and other parts of Asia and Africa. See HORSE.

**HEMIONUS**. Longitudinal dorsal stripe without humeral transverse band; tail hairy at the tip only. *Equus hemionus*, Pallas Nov. Comm. Petrop. v. 19. Gmel. *Czigitai*, Buff.

This curious animal, described by Pallas in the Transactions of the Royal Academy of Petersburg, is supposed by that naturalist to be the hemionos of Aristotle, and which appears, if this conjecture be correct, to have remained almost unnoticed from the time of Pliny, who mentions it as a native of Cappadocia.

## EQUUS.

The *Czigitai*, or, as more commonly called, *Dshiggetai* in the Mongolian language, is a native of the desert regions between the rivers Onon and Argun, in the southern parts of Siberia, and especially those of Gobi, which extend even to the confines of China and Thibet. The name *Dshiggetai* signifies *Great Ears*, and is given to this species of wild horse, because its ears exceed in proportion the size of those of the common kind. They are, nevertheless, straighter and better formed than those of the mule, to which the whole conformation of the animal bears much similitude. His stature is that of a mule of the common dimensions: the length being more than five feet, and his weight from four to five hundred pounds. The head is large, with an appearance of heaviness, and the front flattened: the eyes moderate, with ash-coloured irides. The mouth is furnished with thirty-four teeth. The neck is slender, and compressed with a soft, short, erect mane, and on the fore-top a tuft of downy hair about two inches in length. The body is rather long; the breast large and protuberant; the back somewhat concave or depressed, with the flanks and posterior part thin, as in the mule. The limbs are long and slender, with an oval callus within the fore legs; the hoofs like those of the ass; and the tail, which is two feet in length, corresponding with that of the cow, in being naked for half its length, and having the tip hairy.

During summer the prevailing colour of this animal is yellowish brown, with the upper part of the head and inner part of the limbs tawny, and sometimes the inside of the hind thighs and belly are said to be whitish. The nose is white; the mane and tail blackish; and the back marked with a line of chestnut or deep black, extending from the mane to the tail. The dorsal line is rather dilated on the loins, and becomes narrower towards the tail. The summer coat is much smoother than that which it assumes in winter, for the hair during the latter season is longer, and changes to a deeper or more ruddy hue, inclining at the tips to grey.

These animals are of a social disposition among themselves, living together in troops of twenty or thirty, or sometimes an hundred. They prefer the open plains, abounding in salt marshes; and never approach the forests nor mountainous situations. Each of these troops is placed under the guidance of a leader, who is constantly on the watch while the rest of the herd is at rest, or feeding; and who, in case of danger, gives the signal of alarm, by leaping and looking steadfastly at the object which excites his fears. This vigilant leader is often killed, because he is stationed at some distance from the herd, and oftentimes approaches still nearer to the hunters, in order to watch them attentively; and when he falls the herd does not disperse till many of them are killed. When alarmed and put to flight the best horses could not overtake them; their swiftness surpasses that even of the antelopes. They have the senses of sight and smell in exquisite perfection. In their manners they are naturally timid, but when closely pressed by an enemy are very fierce, and defend themselves both with their teeth and feet. Their neigh is more shrill than that of a horse. The pregnant females are with young from August till the following spring, when each produces a foal, or rarely two.

The *Czigitais* would form an excellent race of small horses, could they be reduced to a state of domestication, but such is the untractableness of their disposition, that the difficulties of training them for this purpose appear unsurmountable. The people of the vast deserts which they inhabit pursue them only for the sake of their flesh and skin, the former of which they esteem a delicacy.

**ASINUS.** Tail bristly at the extremity; a black cross on the shoulders. Linn. **The Ass.**

This animal is described at length under the article **ASINUS.**

**ZEBRA.** Body pale buff, with perpendicular fuscous bands; limbs transversely striped with fuscous. *Equus zebra*, *fasciis fuscis versicolor*, Linn. *Equus indicus*, Jonst. *Equus brasiliensis*, Jacob. *Zecota*, Ludolf. *Asne de beauté extraordinaire*, Thevenot. *Indianisch Maulthier*, Gessn.

The zebra is one of the most beautiful quadrupeds known; uniting to the grace of the horse, and swiftness of the stag, a peculiar combination of colours, that renders its appearance admirable. This animal is rather larger than the common ass, and bears some resemblance to the mule. The head is of moderate size, and well formed, the ears long, the legs delicate, the body graceful, and the beauty of its shape heightened by the smoothness of the skin. The colour is either milk white, or faintly tinged with brown, or pale ferruginous, and the whole animal adorned with alternate pale and fuscous bands disposed with such amazing regularity as to have rather the appearance of art than nature. The stripes run in a transverse direction both on the body and limbs. The head is striped with fine bands of black and whitish, forming a centre in the forehead. The neck is adorned with stripes of the same, running in the same direction as those on the back, all which point perpendicularly towards the belly. The thighs and legs are fasciated transversely with fuscous. The tail is of moderate length, round, rather slender, marked with blackish bands, and terminated by a thick tuft of brownish hair. The colours in the male are remarkably vivid, being sometimes of a fine yellow or yellowish, with the stripes nearly black, the female is almost white, with the stripes brown.

These animals are found in the hotter regions of Africa, from Ethiopia to the Cape of Good Hope; and are in particular met with in great plenty in the extensive solitary mountainous wastes of the latter tract of country. They live in large herds, and possess much of the manners both of the horse and the ass, are excessively swift and vigilant, and prefer subsisting on the hard and dry herbage their sterile haunts afford, to descending into the more fertile and more frequented plains. The disposition of the zebra is more unmanageable than that either of the horse or ass; and even such as have been taken when very young have evinced the same invincible degree of passion for liberty, when grown up, as those caught at an age of maturity. The Dutch have taken great pains to train them for domestic purposes, but with little success, and which is the more to be regretted as the domestication of these animals would be of essential utility to the colony. This is testified from the actual observations of many travellers.

The zebra, transported into the temperate climates of Europe, have been known to produce young; but their offspring degenerates. It has been known to couple with the Arabian horse, and to give birth to a small mule not very unlike the hybrid creature formed between the horse and ass. According to Sparrmann, the zebra is hunted by the Hottentots for the sake of its flesh, which they deem excellent; but, in reality, it is in no respect superior to that of the horse. Le Vaillant describes the manners of these animals; the cry of the zebra, according to this writer, is very singular.

**QUAGGA.** Above chestnut fasciated with fuscous, sides spotted; belly, legs, and thighs white. *Equus quagga*, Gmel. *Opeagha*, or *quagga*, of the Hottentots. Madson's Travels, Phil. Trans.

The quagga approaches so nearly in resemblance to the zebra, as to have remained till very lately confounded with it, and from various circumstances to be considered as the female. This animal is inferior in size to the zebra. The prevailing

prevailing colour reddish brown, and the upper part is marked with bands of black, but one of the principal differences consists in the belly, legs, and thighs being white, and destitute of bands, as are also the flanks and buttocks. There is an obvious distinction between the two sexes of this animal, the colours of the male being far more vivid than those of the female.

The more solitary regions in the southern parts of Africa are the haunts of this beautiful animal. They are of a social disposition, and in a state of wildness, herd in troops of a hundred or more together; and it is observed that though they inhabit the same deserts as the zebra they never associate with that species. The quagga, unlike the zebra, is of a tractable nature: in size it is smaller, but stronger, and in proportion more robust. The attempts of the colonists of the Cape to reduce this animal to a state of servitude, like the horse, has been attended with some success; an instance of this is mentioned by Sparrmann. Quagga, opeagha, and also *owab*, or *kwab*, are the names by which the Hottentots distinguish this animal; its cry resembles the barking of a dog, in which sounds, similar to the latter words, are frequently repeated. Its flesh, which resembles that of the zebra, is eaten by the natives.

#### Appendix.

*Bifidulus*. Hoofs cloven. Gmel. *Guémul*, or *Huémul*, Molina. Hill. Chili.

The cloven-footed, or Chilese horse, is an animal of very ambiguous character, and which, if our suspicions be well founded, will be removed from the equus tribe whenever naturalists become better acquainted with this supposed species than they appear to be at present. The animal seems to have been unknown till observed by Wallis in the straits of Magellan. Molina, in his "Storia Naturale del Chili," describes it as a horse, under the title of *Guémul* or *Huémul*, and, as later writers depend on the authority of Molina for their description of this anomalous animal, it may not be amiss to repeat the particular information his account affords us. The guemul is described by him as resembling in different respects both the horse and the ass; it bears an affinity to both, but cannot appertain to either; the division of the hoofs alone being sufficient to remove it from these apparently congenerous animals. In point of stature and appearance, the texture of the hair, and colour, the guemul, according to Molina, resembles the ass. The form and disposition of the teeth correspond with those of the horse. The ears are not long, as in the ass; they are short, straight, and pointed, as in the horse; neither is the back or shoulders of the guemul marked with the black stripe by which the ass is usually distinguished. The head is better formed than that of the ass, the chest more elegant, and the tail and buttocks more graceful. The internal conformation affords the most obvious diversity; and the voice, dependant, in a material degree, on this interior organization, rather resembles the neighing of the horse than the bray of the ass. Gmelin is not correct in his translation from Molina, when he describes the "structura interna," &c. as corresponding with that of the ass; this point may be thought material to the development of the true character of the animal, and should be therefore mentioned; and the more especially since the same mistake prevails in all the English descriptions of this cloven-footed, or Chilese horse, that we have seen.

Molina speaks of the guemul as an animal of a vicious nature, wild, and of surprizing velocity. It inhabits the heights of the most inaccessible mountainous regions of the

Andes of Chili; and it is said, besides, to be found in other Alpine tracts of South America.

The information upon which this animal is described appears to be not sufficiently explicit. We think the guemul ought not to be retained with the horse or equus tribe. Perhaps it is of the camelus tribe, or that, with still more propriety, it ought to be allowed to constitute a new genus. An ingenious writer observes, that "if only a single specimen of this animal had been described, we might have hesitated as to admitting it otherwise than as an accidental variety." We could have wished the other authorities alluded to had been adduced. The continental naturalists offer argument and speculation dependant on the description given by Molina only; any farther information would therefore prove acceptable. In the Gmelinian "Systema Naturæ" this animal is classed as a horse. Sonnini considers it as allied to the lama, or camelus glama, and camelus vicugna. According to the character "pedes ungula indivisa," established by Linnæus for the equus genus, nothing can be more absurd than a cloven-footed horse. Its affinity to the camel appears rather more evident, or, as before intimated, if it be not of that tribe, it is not improbable that it may constitute a new genus.

*Equus Marinus*, in *Ornithology*, the *Fulmar* of Pennant and Latham, and the *PROCELLARIA Glacialis* of other writers, which see.

*Equus Marinus*, in *Zoology*, a name given by some to an animal very different from the hippopotamus, or river-horse, and more usually known by the name of the *Marje*. See *TRICHECHUS Rosmarus*.

ERA, in *Chronology*. See *ÆRA*.

ERA, in *Geography*, a river of Tuscany, which runs into the Arno; 14 miles above Pisa.

ERABA, a town of Persia, situated on the eastern bank of the river that answers to the Arabius of Alexander and Nearchus.

ERACLISSA, in *Botany*, so named by Forskall, from the Greek village near which he gathered it, is according to Jusseu, no other than *Audrache telephioides* of Linnæus. See Forsk. Fl. Ægyptiaco-Arab. 208.

ERACTUM, in *Ancient Geography*, a town of European Sarmatia, in the country of the Baltharæ, according to Ptolemy. It has been thought to be the modern *Row*, a small town of Podolia.

ERADICATIVE, in *Medicine*. See *RADICAL*.

ERÆ, in *Ancient Geography*, a small maritime, fortified town of Asia Minor, in Ionia, according to Strabo, who says that it was either founded or possessed by the Teians.

ERAGI, a town of Africa, in the Pentapolis, according to Ptolemy.

ERAGISA, RAJIK, a town of Syria, in the Cyrrhastii territory, upon the banks of the Euphrates, according to Ptolemy, situated S. S. E. of Hierapolis.

ERAGROSTIS, in *Botany*, from ερα, *love*, and αγραστis, *grass*, the name of an elegant grass, *Poa Eragrostis* of Linnæus, called in Latin *Gramen Amoris*, and in French *Amourettes*. See Sm. Fl. Græc. Sib. t. 73, where the Linnæan *Briza Eragrostis* is given as a synonym.

ERANA, in *Ancient Geography*, a borough of Asia, in Cilicia; being the chief place of mount Amanus, upon which it was situated; on the same side with the altars of Alexander. Cicero says it resembled a town rather than a village.

ERANARCHA, formed of εραρος, *alms*, *contribution*, and αρχη, *command*, a public officer among the ancient Greeks, whose business was to preside over and direct the alms given, and provisions made for the poor.

The eranarcha was properly the administrator or steward of the poor: when any person was reduced to poverty, taken captive, or had a daughter to marry, which he could not effect for want of money, &c. this officer called an assembly of friends and neighbours, and taxed each, according to his means and estate, to contribute towards his relief. This is what we learn from Cornelius Nepos, in his life of Epaminondas.

ERANG, in *Geography*, a town of the island of Ceylon.

ERANGELIA, in *Botany*, (*Ἡραγγελία*, the herald of spring), a name given by Rensselm in his *Specimen Historiæ Plantarum*, 97, to the Snow-drop. See GALANTHUS.

ERANNA, in *Ancient Geography*, a town of the Peloponnesus, in Triphylia, a province of the Elide. Strabo calls it *Erana*, and places it between Cyparissia and Pylus.

ERANNOBOAS, or ERRANOBOS, a river of India, according to Arrian; situated within the Ganges, into which it discharged itself near the town of Palibothra. This river was of the third degree of magnitude among the Indian rivers, and inferior to none but the Ganges and Indus. Major Rennell cannot apply the name Erranobos to any particular river. Pliny certainly says, that the Jomanes (Jumnah) entered the Ganges by Palibothra, between Methora and Clifobara (otherwise Caryfobora and Cyrifoborea): but it is equally true, that in another place he mentions the conflux of the Ganges and Jomanes, and in the very next article says that Palibothra is situated 425 miles below that very point of conflux. Strabo does not give the name of the adjoining river. See PALIBOTHTHA.

ERANTHEMUM, in *Botany*, from *ἔρα*, the earth, and *ἄνθος*, a flower, according to Linnæus (*Phil. Bot.* 177.) who is the author of the name; but such a derivation is, in the present instance, wholly destitute of any appropriate meaning. We should have supposed it rather from *ἔρα*, love, on account of the beauty of the flower, which might well justify such a denomination; and it is not impossible that Linnæus might have had this idea in his mind when he wrote the *Flora Zeylanica*, but forgot it when composing his *Philosophia Botanica*. Linn. *Fl. Zeyl.* 6. *Diff. Nov. Gen. Pl.* 1. *Am. Acad.* v. 1. 334. *Gen. Pl.* ed. 4. 418. cl. 6. 11. Schreb. 15. Willd. *Sp. Pl.* v. 1. 51. Mart. *Mill. Dict.* v. 2. *Juss.* 110.

*Gen. Ch.* Cal. Perianth five-cleft, tubular, very narrow, erect, short, pointed, permanent. Cor. of one petal; funnel-shaped; tube very long and thread-shaped; limb deeply five-cleft, (occasionally four-cleft), flat, its segments obovate. *Stam.* Filaments two, very short, in the mouth of the corolla; anthers nearly ovate, compressed, projecting beyond the tube. *Pist.* Germen ovate, minute; style thread-shaped, reaching to the top of the stamens; stigma simple. *Peric. and seeds* not known. Linnæus adds, that he had seen only a single specimen, (which by the mark †, was a dried one), and therefore he left the genus to the attentive examination of other botanists.

*Ess. Ch.* Corolla five-cleft; tube thread-shaped. Anthers projecting beyond the tube. Stigma simple. Fruit . . .

Such are the characters given by Linnæus, and copied by Schreber, but the plant whence they were taken being other than a *Jussiaea*, very near, if not the same with *J. palebella*, Roxb. *Corom.* t. 177, *Erantlemum* falls to the ground. Linnæus indeed, in his own *Gen. Pl.* has made the following manuscript corrections: that the two upper segments of the calyx are the shortest; segments of the corolla not obovate but oblong, two of them joined together; anthers within the mouth of the tube.—Whence

these corrections were taken we have no knowledge; probably from some of the plants he subsequently referred to *Erantlemum*, for he certainly never again saw the specimen he originally described from Herman's herbarium, nor had he in his own any thing to illustrate the subject. In the *Species Plantarum* one species only is mentioned, by the name of *E. capense*, said to grow in Ethiopia, and to have the habit of a *Chironia*; yet he comprehends under it the plant of his *Flora Zeylanica*, which, as we have said, is a *Jussiaea*, and with this last the synonyms of Herman's *Paradilus*, Amman and Ray have certainly no connection. In the thirteenth and fourteenth editions of the *Systema Vegetabilium* *Selago dubia* of Sp. Pl. having but two stamens and its fruit not ascertained, is called *Erantlemum angustifolium*; while another species, called *parvifolium*, is adopted from Bergius, along with a synonym of Commelin, who figures it with four stamens and all the aspect of a *Selago*: indeed Linnæus, in his own copy of Bergius, has expressed a suspicion of its being such. *E. falsoides*, from *Teneriffe*, the only supposed species besides is described in the *Suppl. Pl.* but wholly unknown to us. How far the above, and other spiked species of *Selago*, may constitute a genus by themselves, as Jussieu suspects, we must leave in doubt; but if so, they cannot have any thing to do with the name or the above generic characters of *Erantlemum*. S.

ERANUSA, in *Ancient Geography*, a small town of Italy, placed by Pliny near the promontory of Lavinium.

ERARIUM. See *ÆRARIUM*.

ERAS, in *Ancient Geography*, a town of Asia Minor, in Ionia, in the vicinity of Ephesus, according to Thucydides.

ERASED, in *Heraldry*, expresses any thing that seems violently torn off from its proper place. It is used in contradistinction to couped, which signifies a thing clean cut off. The family of Card bears ermine, a demy lion rampant erased, azure, &c.

ERASINUS, in *Ancient Geography*, a river of the Peloponnesus, in Arcadia, according to Strabo, who says that this river had its mouth near Bura, in the gulf of Corinth.—Also, a river of Greece, in Eretria. Strabo.—Also, a river of Greece, in Attica, near Brauron. Strabo.—Also, a river of Asia Minor, in Lycia.—Also, a river of the Argolide, towards the S. E. of Cenchrea, which formed a confluence with the Phryxus.

ERASISTRATUS, in *Biography*, a physician of great reputation among the ancients, but of whose parentage and birth-place, as well as of the æra in which he flourished, different accounts have been transmitted to us by different writers. It appears most probable, however, that he was born at Julis, in the isle of Cea or Ceos, (and not in Cos, the birth-place of Hippocrates, as has been asserted,) that he was the most distinguished pupil of Chrysippus, the Cnidian physician, and had attained a high character in his profession in the 123d olympiad. His fame acquired him the notice and esteem of Seleucus Nicanor, king of Syria, at whose court he is said to have evinced his sagacity in the following manner. Antiochus, the king's son, was seized with a severe malady, and the most ingenious physicians of the time were unable to discover the cause of it; until Erasistratus, observing the prince most attentively, remarked, that whenever Stratonice, his father's second wife, entered his apartment, he became considerably agitated, a blush suffused his countenance, his voice grew more feeble, and his pulse quickened:—whence the physician decided that his disorder was the effect of a concealed passion for Stratonice. In order to inform the king of this delicate affair, he stated that

## ERASISTRATUS.

Antiochus's disease was the result of a passion, the more unfortunate as it could not be gratified. The king, surprised at the impracticability of gratifying the inclinations of his son, demanded eagerly who was the object of his love. "My wife," replied Erasistratus, promptly. Seleucus having urged him strongly not to occasion the death of his son, by refusing to give up his wife, Erasistratus inquired, if he would give up Stratonicæ to save his son's life, were she the object of his affection; with which the king expressed his ready compliance, and Erasistratus vowed that this would be the only means of preserving the life of Antiochus. Seleucus immediately declared him king of the provinces in Upper Asia, and gave him Stratonicæ in marriage, although she had already had one child.

The great character of Erasistratus, however, is founded upon more solid ground than this anecdote displays. He may be considered as the father of anatomical science, at least conjointly with Herophilus. It seems to be clearly established, that, before the time of these physicians, no one had dared to dissect human bodies; anatomical examinations had been confined exclusively to the bodies of brutes. Human bodies had, indeed, been opened for the purpose of embalming, among the Egyptians, but no anatomical inquiry had resulted from that practice. The Ptolemies, especially Soter and Philadelphus, being desirous that the arts should be cultivated, and having surmounted the prejudices of the age, granted the bodies of malefactors to the physicians for dissection, of which opportunity Erasistratus and Herophilus availed themselves largely, and made several important discoveries. To what extent these discoveries were carried, it is not easy to ascertain, since the works of these physicians are lost; and what we learn respecting them is chiefly through the medium of Galen, who deeming Erasistratus in some sort a rival of his idol, Hippocrates, seldom quotes him but to confute him. It is asserted by Celsus (*De Medicinâ, Præfat.*), that the monarchs above-mentioned took the condemned criminals from prison, and gave them up to Erasistratus and Herophilus, who dissected them alive, in order to obtain a more accurate knowledge of the vital motions. (*See EMPIRIC.*) It has been doubted, however, whether they were guilty of this barbarous practice, in consequence of their adoption of the opinion of Praxagoras, that the veins only received blood, and the arteries, and left ventricle, air; since, if they had opened the living body, they must have had ocular demonstration of the existence of blood in the latter: and this imputation is supposed to have been thrown upon them in a fabulous age; just as Medea is said to have boiled living men, because she was the first who practised warm bathing. (*See Eloy Dict. Hist.*) It would appear, however, from the statement of Galen, that the evidence of their senses, upon this subject, was contravened by this sort of subterfuge: "as soon as the left ventricle of the heart is opened," they observed, "the air is dissipated, and the ventricle is instantaneously filled with blood." (*Galen, an sanguis sit naturâ in arteriis.*)

Erasistratus and Herophilus were the first who dissected the human brain accurately; according to the fragments preserved by Galen, Erasistratus described the brain minutely, its convolutions, the division of cerebrum and cerebellum, its cavities or ventricles, with their passages of communication, and the origin of the nerves; and he inferred that the brain was the common sensorium, or source of all the vital actions and sensations, which were effected through the medium of the nerves. (*Galen, De Hippoc. et Platon. decret. lib. vii. cap. 3.*) He also examined minutely the structure of the heart and of the great vessels, and was the first to point out the valvular apparatus, and its peculiar form in each of

the cavities of that viscous. (*Loc. cit lib. i. cap. 10. and lib. vi. cap. 6.*) He affirmed that the veins divided in the liver, for the purpose of secreting the bile; and knew that the urine was secreted by the kidneys.

His physiology, in general, was not, however, very profound, and his pathology necessarily imperfect; although he attempted to explain the causes of diseases from his knowledge of the structure of the body. The function of respiration served, in his opinion, merely to fill the arteries with air. "The thorax being dilated," he said, "the lungs expand at the same time, and receive air: this air passed to the extremities of the divisions of the trachea, and from them into the extremities of the pulmonary artery, whence it is pumped into the heart, by the dilatation of that organ, in order to be distributed to all parts of the body, by the great artery." He attributed digestion to attrition produced by the coats of the stomach; but he did not attempt to explain the particular manner in which the stomach accomplished such attrition.

The hypothesis, by which Erasistratus attempted to explain the origin of inflammation, resembled, in its leading feature, that modern supposition, which, sanctioned by the name of Boerhaave, was generally received in the medical world for a long series of years. (*See ERROR loci.*) He maintained, as we have already stated, that the great vein (*vena cava*) was the reservoir of blood, and the great artery (*aorta*) the reservoir of air. "These reservoirs are divided and subdivided," he affirmed, "until they arrive at the surface, where the ramifications become so minute, that the blood cannot pass farther. Here the mouths or extremities of the arteries and veins close to each other, but the blood continues within its proper bounds, and does not enter the arterial or air-vessels, so that the body continues in the natural state. But when any cause of violence occurs to disturb this regularity, the blood is insinuated into the arteries, and hence the origin of diseases. Among the causes of disturbance just alluded to, too great abundance of blood is the principal; for by it the coats of the veins are preternaturally dilated, and their extremities, which are ordinarily impervious, open, and admit of the passage of the blood into the arteries. This transfused blood becomes an impediment to the course and motion of the arterial spirit or air, which is sent from the heart; and if the opposition of the two matters is direct, or if the blood be arrested near a vital part, a fever is produced; but if the air repel the blood, so that it pass not farther than the extremity of the artery, inflammation of that part is the consequence." (*Galen, de venâ sect. advers. Erasistratum.*)

The practice of Erasistratus, like that of his master Chryssippus, was extremely simple. He did not employ blood-letting, nor purgatives; considering the former as hazardous in the operation, and debilitating in its effects, and the latter as not bringing away the proper humours of the body, but humours in a sort of corrupted state. He sometimes employed glysters, but these of the mildest qualities. All these remedies operated, in his opinion, by reducing plethora, which might be effected more safely and naturally by fasting, or abstinence in diet, especially when aided by exercise. He advised his patients, therefore, to use such articles of diet as contained little nutriment, as melons, cucumbers, and vegetables in general. He was exceedingly averse from the employment of compound medicines, and especially of the mixture of mineral, vegetable, and animal substances; and he exclaimed against the use of the antidotes of the physicians of his day, in which simplicity was altogether shunned.

From the fragments of his writings to be found in Galen and

and Cælius Aurelianus, it would appear, that Erasistratus wrote an accurate treatise on the dropsy, in which he disapproves of the operation of tapping; and that he had left other books on the following subjects:—*viz.* on the Diseases of the Abdomen, on the Preservation of Health, on wholesome Things, on Fevers, and Wounds, on Habit, on Palsy, and on Gout.

Having lived to extreme old age, and suffering severely from the pains of an ulcer in the foot, Erasistratus is said to have terminated his existence by swallowing the juice of cicuta, or hemlock. See Le Clerc, *Hist. de la Médecine*, Eloy, *Dict. Hist. Cælius Aurcl.*

ERASMUS, DESIDERIUS, a man of great celebrity in the republic of letters, was born at Rotterdam on the 28th of October, 1467. He was the natural son of Gerard, a native of Tergou, by Margaret the daughter of a physician, whom he intended to marry, but being deceived by a report of her death, he entered into the church, and on this account Erasmus has been called, by way of reproach, the son of a priest, though his father was not in orders at the time of his birth. When Erasmus was about nine years old he was sent to school at Deventer, where he made very considerable progress in learning, and was particularly distinguished by the excellence of his memory. His mother, who followed him to Deventer, to watch over his health, died of the plague when he was about 13 years of age. He was now left an orphan, and his guardians, forgetful of the sacred trust reposed in them, forced him into the church with a view of embezzling his property. Erasmus resisted their importunity for a considerable time, but at length, when he was nineteen years old, he entered among the regular canons in the monastery of Stein, near Tergou. He was of a delicate constitution, and his health was not sufficiently robust for the life of a monk. His temper and sentiments were likewise averse from the habits of the profession; he accordingly, with the leave of his superiors, accepted, in his 23d year, an invitation to reside with the archbishop of Cambray; but finding the patronage of that prelate not equal to his expectations, he went to Paris and studied in the college of Montaigne. Here he supported himself by giving private lectures to those who were less advanced in their learning than himself. His necessities required great exertion, and thus he acquired habits of industry which raised him to the highest pitch of literary excellence. Some of his pupils at Paris were the sons of Englishmen of considerable consequence, by whose liberality and earnest request he visited their country, and contracted many valuable friendships. This was in the year 1497; from England he went to Italy, continued a year or more at Bologna, from thence to Venice, where he published his *Adagia*; afterwards to Padua, and at last he visited the capital, Rome, where his reputation was very high, and where he might have settled to great advantage, had he not determined, at the entreaties of his friends, and by the express invitation of Henry VIII. to return to England. Henry, while prince, had contracted a friendship and high respect for Erasmus, and in a few months after he succeeded to the crown, we find Erasmus at the court of London high in favour with the monarch, with Wolsey, with the archbishop of Canterbury, and with other persons of distinction.

At first he lived with sir Thomas More, under whose roof he wrote his "*Morizæ Encomium*," or "*Praise of Folly*," a witty and satirical composition. He afterwards went to Cambridge, and read lectures to the students in Greek and theology. For this he was remunerated with a living and many valuable presents, though not of so substantial a nature as to satisfy his expectations. He wished for an

independency, and not being able to secure that in England, he went over to Flanders in 1514, and was shortly after created nominal counsellor to prince Charles of Austria, with a stipend. Soon after this he paid a visit to Basil, where he formed an intimacy with some valuable friends, which induced him to spend his latter days in that place. At Basil he published, in the year 1516, his New Testament, in Greek and Latin, which was received with the utmost eagerness by all those whose minds were turned to theological pursuits. It was dedicated to Leo X. In the course of the same year, his edition of St. Jerome, a favourite author, made its appearance, which he inscribed to his generous patron, archbishop Warham. Erasmus was ever inimical to that system of war which in his time, as in ours, was but too much in fashion among the ambitious rulers of mankind; he published, in 1517, a work entitled "*Querela Pacis, undique gentium ejectæ profligatæque*," which is written with much strength of reasoning and true eloquence. By his contemporaries he was charged with maintaining the unlawfulness of war on all and every occasion: this, however, was a calumny invented by his enemies, of whom he had many, for, in the work alluded to, he expressly says he is speaking only of wars undertaken on trifling and unjustifiable occasions. "I think," says he, "very differently of wars, which are strictly and purely defensive, such as with an honest and affectionate zeal for the country, repel the violence of invaders, and at the hazard of life, preserve the public tranquillity." He was aware of the horrors and atrocities of a state of warfare, and thought almost any sacrifice might be made by wise princes to prevent it. He undertook to vindicate the cause of peace, whom he makes the speaker on this occasion. But the arguments which he puts into her mouth, and the persuasive eloquence with which she addresses the sovereign princes of those dark times, as they are sometimes called, would scarcely be borne by the monarchs of Europe in this enlightened age. His descriptions are vivid, and his reflections but too just: "*Exuruntur vici, vastantur agri, diripiuntur templa, trucidantur immeriti cives, dum princeps interim otiosus ludit aleam, dum saltitat, dum delectat se morionibus, dum venatur, dum amat, dum potat. O Brutorum genus jam olim extinctum! O fulmen Jovis aut cæcum aut obtusum.*" To whom this is particularly applied it does not appear, but the "*Querela Pacis*" was occasioned by the following remarkable circumstance:

It was a favourite project at this period to assemble a congress of kings at Cambray, consisting of the emperor of Germany, the kings of France, England, and the Low Countries; "of which," says the author, "I am a native. They were to enter into mutual and indissoluble engagements to preserve peace with each other, and throughout Europe. This momentous business was very much promoted by William a Ciervia, and by one, who seemed to have been born to advance the happiness of his country, and of human nature, John Sylvagius, chancellor of Burgundy. But certain persons, who get nothing by peace, and a great deal by war, threw obstacles in the way which prevented this truly kingly purpose from being carried into execution. After this great disappointment, I sat down and wrote, by desire of Sylvagius, my *Querela Pacis*." This work was dedicated to Philip of Burgundy, bishop of Utrecht, who was likewise a zealous promoter of peace, and who, so far from being offended with the free sentiments of the book, thanked the author, and even pressed him to accept a living, as a remuneration, which he civilly refused. Erasmus sought no preferment, though, says his biographer, he merited the highest: he sought the happiness of his fellow creatures, and felt himself abundantly rewarded by his own conscience,

and their approbation. The bishop, however, in token of his high esteem, sent him a most beautiful ring, set with a sapphire, which his own brother, his predecessor, in the bishopric, had constantly worn, and which he desired Erasmus to wear for his sake.

The commencement of the reformation, under Luther, was a circumstance of considerable importance in the life of Erasmus. He had thence himself inimical to the superstitions of the times, he had arranged the principles and practices of the monks, and had done much to undermine the whole system of popery, and to expose the various frauds which had been attached to its observance by avaricious and licentious priests; yet he was not prepared to join the reformers as such, his zeal was not sufficient to enable him to endure persecution: he did not wish to break openly from the church, nor was he quite satisfied with the doctrines of the reformers, and still less was he disposed to coincide with the rudeness, vulgarity, and contempt of polite literature which characterized some of that class of people. It has also been said that he was very desirous of being noticed by the great, that he had habituated himself to that degree of indulgence, which would render the prospect of poverty and imprisonment absolutely insupportable to his mind. His income likewise arose almost entirely from pensions which he received from crowned heads, prelates, and men of consequence belonging to the Catholic persuasion, which he would unquestionably have lost had he gone over to the opposite side. These are the reasons which have been assigned why Erasmus did not come boldly forward in defence of the reformation; but with these deductions there is enough in his character to challenge the admiration and gratitude of the friends to liberty and the human race. He was ever the undaunted advocate of free enquiry, and perpetually waged war against the ignorance and bigotry that characterized the age in which he lived. On these accounts he was, in the first years of the reformation, highly regarded by Luther, and it was owing to some unadvised, and, probably, unwarranted attacks made upon Erasmus, about the year 1520, by the zealous reformers, that he was driven to enlist among the defenders of the church of Rome.

In the year 1522, he published his "Colloquies," which, though apparently intended for young persons, were generally read, and are supposed to have been very efficacious in promoting the principles of the reformation. As soon as their tendency was discovered, the clergy attempted to stop their sale, but it was then too late; more than twenty thousand copies of them were disposed of in Paris, besides a number of editions which were printed and sold in other places.

In 1524, Erasmus published his treatise, "De Libero Arbitrio," which was an avowed attack upon Luther's opinion concerning predestination, but the author, in his zeal, spoke against reformers in general; Luther replied, and had unquestionably the best of the argument: in some passages he seemed to commiserate the case of his antagonist, and to regret the necessity that he was under of exposing him. "We saw," says he, "that the Lord had not conferred upon you the discernment, the courage, and the resolution to join us in opposing those monsters, and therefore we dared not to exact from you that which greatly surpasses your strength and capacity." He then refers to the motives of worldly interest by which Erasmus had suffered himself to be swayed from the path of rectitude. The controversy increased in violence, and much unjustifiable acrimony proceeded from the pens of the disputants. Under the article REFORMATION we shall have occasion to enter more at large into this subject, and also into the controversy between Erasmus and Melancthon.

Another antagonist with whom our author had to contend was Julius Cæsar Scaliger, who had put himself at the head of those who were so fastidious in the use of pure Latin as to reject every word not to be found in the works of Cicero, and who on that account had assumed the title of "Ciceronians." Erasmus, superior to this pedantry, employed new words for new ideas, and in justification of his conduct published, in 1528, a dialogue entitled "Ciceronianus," in which he attacked the sect both with argument and ridicule. Scaliger wrote against him with all the malignity that human wit and learning could devise, and he was backed in his scurrility by others of the Ciceronians less able in the warfare, but not less inveterate than their master. The nature of this controversy is fairly exhibited in the notes on the life of Erasmus by Bayle.

Erasmus, wearied, perhaps, by disputation, published, in a short time after his "Ciceronianus" had made its appearance, a treatise of much ability and learning, entitled "De Recta Latini Græcique sermonis Pronunciatione." In the year 1529, Erasmus left Basil for Friburg, in order to shew his attachment to the church which had for some years been losing ground in Basil, and so completely had the reformed religion gained an ascendancy there at this period, that all the images were taken from the town-house and other public places and burnt, which was supposed to have been the means of putting an end to the differences among the common people. Erasmus was now advancing in life, and seemed, more than ever, fearful of being thought friendly to the reformation, and to shew his zeal for the opposite system he wrote and published an epistle against some "who falsely call themselves Evangelists," and as they, from his former works, had produced his authority against persecution, he began to maintain that there were certain cases in which they might lawfully be punished capitally as blasphemers and seditious persons. Such were the unworthy steps to which he was led by an anxiety to keep on good terms with his patrons and protectors.

In 1535 he returned to Basil, and so highly was he esteemed by the church of Rome, that there was an intention to give him a place in the college of cardinals; but it was too late for him to accept of the high honour. His health rapidly declined, and on July 12, 1536, he died of a dysentery at the age of sixty-nine. He was buried with great funeral pomp in the cathedral church of Basil, where his tomb still remains. By his will he left legacies to several friends, and the residue of his property he devoted to charitable purposes. In person he was below the middle size, well-shaped, of a fair complexion, with a cheerful countenance, a low voice, and agreeable elocution. He had assumed the name of Erasmus in conformity with the pedantic taste then prevailing among men of letters of taking names of Greek or Latin etymology; he translated his name of "Gerard," signifying "Amiable," into the equivalent ones of "Desiderius" in Latin, and "Erasmus" in Greek, making use of both, but the latter was his common and perpetual appellation.

Erasmus was a voluminous writer; and his works were published in nine volumes folio. They consist of numerous translations from the Greek; of grammatical and philological pieces; of poems, declamations, and orations; of a collection of adages and apophthegms; of works in divinity on various topics, moral, didactic, and controversial; of a version of the New Testament, paraphrases of the gospels and the epistles, and commentaries on some other parts of scripture; and of apologies, epistles to correspondents, &c. A new and handsome edition of his works was published in Holland by Le Clerc in eleven volumes folio,

1703. Dr. Jortin, the biographer of Erasmus, speaking of his Latin style, says, it "is that of a man who had a strong memory, a natural eloquence, a lively fancy, and a ready invention, who composed with great facility and rapidity, and who did not care for the trouble of revising and correcting; who had spent all his days in reading, writing, and talking Latin; for he seems to have had no turn for modern languages, and perhaps he had almost forgotten his mother-tongue. His style, therefore, is always unaffected, easy, copious, fluent, and clear; but not always perfectly pure and strictly classical."

No one contributed so much as Erasmus to throw discredit upon the barbarism and ignorance of the schools, or to make literature agreeable, and connect it with good sense and solid criticism. He was a great public benefactor; and therefore he is justly regarded as one of the principal glories of his age and country. His memory is equally honoured at the place of his birth and of his death. Several of his relics are preserved at the latter place, and at the former, the house in which he was born, is marked with an inscription, and his statue decorates the great square. Jortin's life of Erasmus. Bayle. Complaint of Peace. 1802.

ERASMUS, in *Geography*, a mountain of the island of Ceylon; 30 miles N.W. of Trincomaly.

ERASTIANS, in *Ecclesiastical History*, a religious sect or faction, which arose in England during the time of the civil wars, thus called from their leader, Thomas Erastus, a German divine of the sixteenth century, whose distinguishing doctrine was, that the church had no right to discipline, that is, no regular power to excommunicate, exclude, censure, absolve, decree, or the like.

According to the founder of this sect, the pastoral office was only persuasive, like a professor of the sciences over his students, without any power of the keys annexed. The Lord's supper and other ordinances of the gospel were to be free and open to all. The minister might dissuade the vicious and unqualified from the communion, but might not refuse it, or inflict any kind of censure; the punishment of all offences, either of a civil or religious nature, being reserved to the magistrate. The pretended advantage of this scheme was, that it avoided erecting *imperium in imperio*, or two different powers in the same civil government; it effectually destroyed all that spiritual jurisdiction and coercive power over the consciences of men, which had been challenged by popes, prelates, presbyteries, &c. and made the government of the church "a creature of the state." Most of our first reformers adopted these sentiments so far as to maintain, that no one form of church government is prescribed in scripture as a rule for future ages, as Cranmer, Redmayn, Cox, &c. and archbishop Whitgift, in his controversy with Cartwright, delivers the same opinion. The Erastians formed a party in the Assembly of Divines in 1643, and the chief leaders of it were Dr. Lightfoot, Mr. Colman, Mr. Selden, and Mr. Whitlock; and in the house of commons there were, besides Selden and Whitlock, Oliver St. John, esq., sir Thomas Widdrington, John Crew, esq., sir John Hipley, and others of distinguished reputation. In the assembly, the Erastians did not except against the presbyterian government as a "political institution," proper to be established by the civil magistrate, but they were against the claim of a "divine right." Accordingly the clause of divine right was lost in the house of commons. Neal's Hist. Purit. vol. ii. 4to.

ERASTUS, THOMAS, in *Biography*, a physician, was born, in 1523, at Auggenen, a village in the district of Badenweiler, in Switzerland. He studied at Basil, where he was seized with the plague in 1542, and narrowly escaped

death. He suffered a long and tedious convalescence, which, together with his poverty, threw an almost insurmountable impediment in the way of his studies; but he fortunately found a generous protector, who opened the door of the sciences to him, and furnished him with the means of travelling to Italy. He took up his residence at Bologna, where his proficiency in the study of philosophy and medicine was such, that he obtained the honour of the degree of doctor of these two sciences. Finding himself in a short time holding a distinguished situation among the men of learning, he followed the custom of the times by changing his name; giving a Greek turn to his original name, which was Lieber, (beloved,) he called himself Erastus. Under this appellation he became a teacher of medicine at Heidelberg, where he obtained considerable reputation; and in 1581 he was called to fill the medical chair in the university of Basil. But this honourable situation he did not long enjoy; he died on the 1st of January, 1583.

He left many works behind him, of which some were printed during his life, and others have been published since his death; their contents, however, are not particularly interesting; the following is a list of their titles and editions. "Disputationum de Medicina nova Philippi Paracelsi," p. i. Basil, 1572, p. ii. ibid. 1572, p. iii. ibid. 1572, p. iv. et ultima, ibid. 1573, all in 4to. In these volumes he refutes the doctrines which Paracelsus had previously taught at Basil, and had committed to writing. 2. "De Causa Morborum Continente," 4to. 1572. 3. "De Occult. Pharmacorum. Potestatibus," 4to; ibid. 1574; Francofurti, 1611. 4. "Disputat. de Auro Potabili," 4to. Basil, 1578, 1594. 5. "De Putredine Liber," 4to. ibid. 1580; Lipsiæ, 1590. 6. "Epistola de Astrologia Divinatrice," 4to. Basil, 1580. 7. "De Pinguedinis in Animalibus Generatione et Concrecione," 4to. Heidelbergæ, 1580. 8. "Comitis Montani, Vicentini, novi Medicorum censoris, quinque Librorum de Morbis nuper Editorum Viva Anatomie," 4to. Basil, 1581. 9. "Ad Archangeli Mercenarii Disputationem de Putredine responsio," 4to. ibid. 1582. 10. "Varia Opuscula Medica," folio, Franc. 1590. See Eloy Dict. Med. Biog. Dict.

ERATO, from *εραω*, *I love*, in *Mythology*, the name of one of the nine Muses who presided over love-poetry. "By Erato," says Callimachus in his epigram on the nine Muses, "the pious hymn was made." To this Muse some have ascribed the invention of the lyre and lute; but particularly the psaltery or long lyre of nine strings; and she is represented with a garland of myrtles and roses, holding a lyre in one hand, and a bow in the other, and at her side a Cupid with his torch. In the portraits of Apollo and the Muses, dug out of Herculaneum, Erato is exhibited holding a plectrum or bow in her right hand, and seeming to play with the fingers of her left. The psaltery, or lyre, is more than twice the length of that in the hand of Terpsichore. (See MUSES.) There is also a Nereid of the same name.

- ERATONOS, in *Ancient Geography*, islands of the Arabic gulf. Pliny designates their aridity by the epithet *Sitientes*.

ERATOSTHENES, in *Biography*, an eminent Greek mathematician, philosopher, and chronologist, was born at Cyrene in the second year of the 126th olympiad, or 275 B. C. He was educated under Aristotle, the philosopher of Chios, and Callimachus, the poet; and he himself had several disciples who were eminent, and among the number was Aristophanes of Byzantium, one of the most celebrated grammarians of his time. Such was the fame of Eratosthenes as a man of extensive erudition, that he was denominated *πρωτελλος*, *i. e.* victorious in five contests, alluding

to the five prizes of the Olympic games, and expressing his pre-eminence in all kinds of literary pursuits. He was also styled the cosmographer and father of chronology, the measurer of the universe, and the second Plato. On the invitation of Ptolemy Euergetes, he removed from Athens to Egypt, and succeeded Zenodotus in the office of librarian to the famous library at Alexandria. This office he retained under three successive princes, discharging his trust with singular honour, and acquiring high reputation for literature and science by his writings and discoveries. Availing himself of the multitude of historical memoirs, which the library furnished, he was both prompted and enabled to determine the dates of many distinct facts, by laying down certain chronological canons, for which see CHRONOLOGY. He also employed his eminent abilities and learning, with equal success, in reducing geography to a regular system, and laying its foundation upon clear and solid principles. He likewise first introduced into his map a regular parallel of latitude, which was a geographical outline traced over certain places, whose longest day was observed to be exactly of the same length. He began it from the straits of Gibraltar, and it thence passed through the Sicilian sea, and near the southern extremities of Peloponnesus, and was continued through the island of Rhodes and the bay of Issus, and then entering Cilicia, and so crossing the Euphrates and Tigris, was extended to the mountains of India. By means of this line he endeavoured to rectify the errors in the ancient geographical map, supposed to be that of Anaximander. In drawing this parallel, he was regulated by observing when the longest day consisted of  $14\frac{1}{2}$  hours, which Hipparchus afterwards determined to be the latitude of  $36^\circ$ . The running of this parallel through Rhodes was a happy thought of Eratosthenes, because it not only encouraged him to trace upon his map other parallels at certain intervals from his first, such as one through Alexandria, another through Syene, and another through Meroe, but he undertook to trace at right angles to these a meridian passing through Rhodes and Alexandria down to Syene and Meroe. His progression this way enlarged his ideas with regard to the sciences of geography and astronomy, and induced him to attempt a more arduous task, which was that of determining the circumference of the globe by an actual measurement of one of its great circles, making his computation upon the whole by uniting certain accurate observations made in the heavens with a corresponding distance carefully surveyed, and taken upon a meridian of the earth. The segment of the meridian which he fixed upon for this purpose, was that between Alexandria and Syene, the distance of which was measured, and found to be 5000 stadia, and the angle of the shadow upon the scaphia, or sun-dial, which was observed at Alexandria, was equal to the 50th part of the circle; for at Syene there was no shadow from the gnomon at the mid-day of the summer-solstice; and that this might be more accurately taken, they dug a deep well, which being perpendicular, was completely illuminated at the bottom, when the sun was vertical. The substance of this account was taken from Cleomedes, who seems to have extracted it from Eratosthenes's original work, entitled *Μέγεθος*. (See Fabr. Bell. Græc. vol. ii. p. 477.) And it is published as such at the end of the Oxford edition of Aratus in 1672, though under the title of *Μέγεθος τῆς γῆς περιφέρειας*. By this account Eratosthenes made the circumference of the earth amount only to 250,000 stadia, whereas a multitude of original authors, (such are Strabo, Geminus, Vitruvius; Macrobius, Pliny, Capella, and Censorinus,) have uniformly given the numbers to be 252,000. In order to reconcile these differences, Dr. Murdoch (Enquiries con-

cerning Measures of length, prefixed to Busching's Geography, vol. i.) has ingeniously supposed, that instead of  $7^\circ 12'$ , the difference of latitude was  $7^\circ 8\frac{1}{2}'$ , which was the  $\frac{1}{3}$  of the circumference, which would bring the calculation to 252,000 stadia, and that Cleomedes neglected the small fractional part of the denominator; but that the principal mistake was in measuring the distance, and finding it to be 5000 stadia. Eratosthenes, by making the circumference to be 250,000 stadia, allowed 700 stadia to a degree, which, by the reduction of 8 stadia to a Roman mile of 5000 feet, amounted to  $87\frac{1}{2}'$  Roman miles to each degree. We shall return from this digression, after observing, that the map of Eratosthenes appears to have contained little more than the states of Greece, and the dominions of the successors of Alexander, digested from preceding surveys. He had seen indeed, and has quoted the voyages of Pytheas into the great Atlantic ocean, which gave him some faint idea of the western parts of Europe; but they were so imperfect, that they could not be realized into the outline of a chart. Strabo tells us that he was extremely ignorant of Spain, Gaul, Germany, and Britain, as well as of the Gæti and Bastarni; he was equally ignorant of Italy, the coasts of the Adriatic, of Pontus, and of all the countries towards the north. And he mentions in another passage, that Eratosthenes had made the distance from Epidamnus, or Dyrrhachium, on the Adriatic, to the bay of Thermæ on the Ægean sea, quite across Epirus, to be only 900 stadia, when it was really above 2000 stadia; and in another instance he had enlarged the distance from Carthage to Alexandria to be 15,000 stadia, whereas it amounted to no more than 9000 stadia.

Eratosthenes also observed the obliquity of the ecliptic, which, in the year 230 B. C. he makes  $23^\circ 51' 20''$ . (See ECLIP TIC.) In an epistle to king Ptolemy he gave a solution of the problem for the duplication of the cube; and he invented a convenient method of discovering the primary numbers, that is, such as have no common measure but unity, which has been called the sieve of Eratosthenes. He wrote also numerous treatises in grammar, astronomy, history, and geography, together with dialogues on the philosophical sects, and poems. Fragments merely of his different pieces have reached our times, some of which were published at Oxford in 1672, with brief annotations, in 8vo. These fragments were also printed in the Uranologium of Petavius at Paris in 1630, and afterwards at Amsterdam in 1703. The most valuable remnant of his works is his "Catalogue of the kings of Thebes in Egypt, from Menes, who first peopled Egypt after the deluge, to the time of the Trojan war." This contains a series of 38 kings in a direct line of succession, taken not only from the records in the Alexandrian library, but from the sacred archives in Diospolis, or Thebes itself, and probably intended for supplying the defects, and correcting the errors of Manetho's dynasties. This has been used by some of our ablest chronologers as an authority for settling the Egyptian chronology. Eratosthenes died at the advanced age of 80 or 81, having, as some authors report, starved himself to death, because he was unable to bear the depression of spirits occasioned by the decay of his sight. Suidas. Voss. de Hist. Græc. Fab. Bib. Græc. Moren. Anc. Un. Hist. Gen. Biog.

ERBACH, in Geography, a small town of Germany, in the circle of Franconia, anciently called Erdtpach, with an old castle, belonging to the counts of Erbach, who, before the dissolution of the German empire, had two voices at the diet of Ratisbon, in the college of the imperial counts of Franconia. The whole county is about 25 miles in length, and 20 miles in breadth; its population does not exceed the

number of 30,000 individuals. It is a mountainous country, but tolerably fertile, and producing both corn and wine; of the latter, that of Schouberg, near the Bergstrasse, is reckoned the best.

ERBAT, a town of Asiatic Turkey, in the province of Diarbekir; 58 miles S.E. from Diarbek.

ERBAZ, a town of Asiatic Turkey, in the province of Natolia; 36 miles W.S.W. from Deguzlu.

ERBITA, in *Ancient Geography*, a town of Sicily, written Herbita by Cicero. It is thought to be the modern *Nicosia*.

ERBLSPACH, or ERLSBACH, in *Geography*, a town of Germany, in Lower Bavaria; 34 miles E.S.E. from Ingolstadt.

ERCABUM, in *Ancient Geography*, a town of European Sarmatia. Ptolemy.

ERCE, in *Geography*, a town of France, in the department of the Ille and Vilaine, and district of Bain; 15 miles E. from Bain.

ERCEUS, of *επος, septum*, in *Mythology*, the name by which those who were appointed to guard the walls of a city invoked Jupiter. This appellation, sometimes written *Herseus*, was given to Jupiter, because his altars, especially in the houses of princes, stood under the open air in places inclosed with walls.

ERCHEE, in *Geography*, a town of Persia, in the province of Adirbeitzan; 60 miles E.N.E. of Tauris.

ERCILLA Y ZUNIGA, DON ALONZO DE, in *Bio-geography*, an eminent Spanish poet, was born at Madrid in 1533. His father, descended from a noble family, pursued the profession of the law, but dying while Alonzo was an infant, the child and his mother were received into the household of Isabella, wife of Charles V. Alonzo, as soon as his years permitted, was made page to the infant don Philip, whom he attended in his progress through the Low Countries, and part of Germany and Italy. He afterwards accompanied the same prince to England, to celebrate his marriage with queen Mary. During their stay here intelligence was received of a revolt in Chili, upon which troops were immediately sent off, with whom Ercilla embarked and proceeded to Lima. His duty required him personally to engage in a subsequent war with the Araucanians, whose courage and love of liberty he admired, and even applauded, though he was under the necessity of using all his efforts in subduing them. The intervals of warfare he employed in recording, in heroic verse, the interesting scenes to which he was witness. After he had escaped the dangers of the expedition, he had nearly lost his life at a tournament exhibited in honour of the accession of Philip II. During the fête a dispute arose between Ercilla and another gentleman; swords were drawn, and many joined in the conflict, which being construed into a plan of mutiny by the governor, he hastily, and without examining into the matter, condemned the principal disputants to be beheaded. Ercilla was led to the scaffold, and his innocence was demonstrated but just in time to save him from an ignominious death. He returned to Spain with his health very much impaired, in his twenty-ninth year; but after a very short stay at home, he commenced a tour through various parts of Europe; but with what particular view has never been ascertained. In 1570 he married, and was made gentleman of the bed-chamber to the emperor Rodolph II. Ten years after this, he was found residing at Madrid, in retirement and poverty. The king whom he had served, and to whom he dedicated his poem "Araucana," made him no requital for his services, and little more is known of him, than the mention made by a contemporary of his being engaged, in 1596, in celebrating

the victories of the marquis of Santa Cruz, in a poem that has never been published.

The "Araucana" is an historical poem, containing a narrative of real events, interspersed with fabulous circumstances. It contains 37 cantos, is formed on no regular plan, but is an unconnected series of adventures. The verse is said to be flowing and spirited, though sometimes it is profane and insipid. Mr. Hayley, in his Essay on Epic Poetry, has taken pains to make Ercilla known to the English reader, by translations of select parts, and an analysis of the whole poem. Gen. Biog. Hayley on Epic Poetry.

ERCTA, in *Ancient Geography*, a mountain of Sicily, near mount Erix. Diod. Sic. Polybius.

ERCYNA, a river of Greece, in Eæotia, not far from the cave of Trophonius.

ERDENI-TCHAO, in *Geography*, a town of Chinese Tartary, in the country of the Eluths; 680 miles N.W. of Peking.

ERDER, a town of Germany, in the circle of Westphalia, and country of Lippe; 12 miles N.N.E. from Lemgow.

ERDMANSDORF, a town of Germany, in the circle of Upper Saxony, and circle of Erzgeburch; 5 miles E. of Chemnitz.

EREBENNUS, *ερεβενδος*, a name given by Galen and some other of the Greek writers, as a distinctive epithet for the black chamæleon thistle, which was esteemed poisonous, and was by this word distinguished from the ægleus, or *αργυρε*, or white chamæleon, which was an esculent plant, and used by some as an antidote. It has happened, however, that the white chamæleon thistle has been by some called a poison, as well as the black; but this is only owing to a mistake of Pliny, in supposing the effects of birdlime to have been attributed to this plant, because of its yielding a viscous, but safe gum, at its root. It was called by some *ixias chamæleon*. See IXIAS.

EREBINTHUS, in *Botany*, (*ερεβινθος*), an ancient Greek name for some kind of vetch or legume), was applied by Mitchel to a supposed new genus of his own, which is the *Galega virginiana* of Linnæus. The latter in his Sp. Pl. inaccurately quotes Mich. Gen. which should mean Micheli, and professor Martyn, under his *Galega*, sp. 4, has Mant. Gen. both which would be unintelligible without an explanation.

EREBUS, *ερεβος*, from *ערב*, night, in *Mythology*, a term denoting darkness. According to Hesiod, Chaos engendered Erebus and Night, from whose mixture was born æther and the day. Aristophanes, ridiculing some ancient system of theogony, in his comedy of the Birds, introduces one of his actors as saying, that in the beginning were the Chaos, the black Erebus, and the vast Tartarus; but as yet there was neither earth, nor air, nor heavens. Night, with her sable wings, laid the first egg in the womb of Erebus, whence sprung, after some time, beneficent love, adorned with golden wings. From the union of love with chaos, arose men and animals. This was also the name of part of the inferi among the ancients: they had a peculiar expiation for those who were detained in Erebus.

Erebus was properly the gloomy region, and distinguished both from Tartarus, the place of torment, and Elysium, the region of bliss: according to the account given of it by Virgil, it forms the third grand division of the invisible world beyond the Styx, and comprehends several particular districts, as the limbus infantum, or receptacle for infants; the limbus for those who have been put to death without cause; that for those who have destroyed themselves; the fields of mourning, full of dark groves and woods, inhabited by those

those who died for love; and beyond these, an open campaign country for departed warriors. *Æn.* lib. vi. p. 427. &c.

EREC, or ERECH, in *Ancient Geography*, a town of Chaldæa, which is mentioned in the book of Genesis (ch. x. v. 10), as one of the places in which Nimrod began to establish his kingdom. This was probably the Aracca, placed by Ptolemy in Susiana, on the river Tigris, below its confluence with the Euphrates. Ammianus calls it Arecha. From this city the Aræctæan fields, which abound with Naphta, and sometimes take fire; derive their name.

"Ardet Aræctæis aut unda per hospita campis."

Tibull.

EREC, a province of Asia, which extended on both sides along the common bed of the Tigris and Euphrates, from their junction to the sea.

ERECT FLOWERS, in *Botany*, are such as grow upright, without hanging or reclining the head. See FLOWER.

ERECT leaf, *erectum folium*. See LEAF.

ERECT, in *Fortification*. The defences of a face, in fortification, are said to be erect when the several works bear directly and regularly upon the approaches, in such manner as to tend uniformly towards the capital, from which they are drawn respectively. Thus, when the two bastions which defend a curtain are equal and similar, and the raveline, with all its dependencies, stands evenly upon the line, or capital, of that face, without obliquity, or curve, the whole of such defences are said to be erect. It will be readily understood, that in every regular fortification the whole of the defences will be of this description: and that in all irregular fortifications there will probably be a mixture of erect and of oblique defence. The latter is by no means to be considered a defect; since innumerable cases might occur in which the prolongation, or the curtailment of any particular part, such, for instance, as the face or flank of a bastion, might be indispensably necessary, either to make way for some natural advantage, or to prevent that kind of weakness which might otherwise be entailed by the proximity of some height, whence enfilading might be successfully practised. When, therefore, the two bastions are dissimilar, or when they are unequal, so as to render the flanked angle of either less distant on the capital, if a line of defence were to be drawn upon, and formed from, the two extremities of such unequal bastions, the raveline must either stand a little obliquely, or the bastions must be unequally protected by it. This kind of obliquity is extremely rare, and is often neglected where great accession of strength might otherwise, by its adoption, be given to weak parts: it is peculiarly appropriate to fortresses, of which only one or two faces are understood to be subject to approach.

ERECT *Vision*, in *Optics*. See VISION.

ERECT, *direct*, and *declining*, &c. *dials*, &c. See DIAL.

ERECTHEUS, in *Biography*, is reckoned the 6th king of Athens, from Cecrops its founder, and is supposed to have succeeded his father Pandion about the year 1397 B. C. Some have referred to this reign the arrival of Ceres in Attica, after the rape of her daughter Proserpine, who taught the cultivation of corn, about the year 1383 B. C. and the institution of the Eleusinian mysteries. Erectheus reigned 50 years, and was slain in a battle with the Eleu-  
sians.

ERECTHIA, in *Ancient Geography*, a municipal place of Greece, in Attica, belonging to the Egeid tribe, and deriving its name from king Erectheus. It was the native place of the orator Isocrates.

ERECTION, the act of raising or elevating a thing in a right line.

The erecting of a perpendicular on a line given, is a popular problem in geometry. See PERPENDICULAR.

The term erection is also used figuratively; as the erection of a marquise into a duchy; bishoprics can only be erected by the king.

ERECTION, in *Physiology*, is the change in the state of the male penis, by which that organ is rendered capable of entering the vagina of the female, for the purposes of sexual intercourse. See GENERATION.

ERECTOR, in *Anatomy*, a name given to two muscles supposed to possess the power of bringing the organs with which they are connected into an erect state. They are the erector penis of the male, and erector clitoridis of the female subject. See GENERATION.

ERECTUM, FOLIUM, in *Botany*. See LEAF.

ERECTUS, CAULIS, an upright stem. See CAULIS, n. 6.

EREGEM, in *Geography*, a town of Flanders; 10 miles S.W. of Bruges.

EREGMOS, from ερημα, *I break*, a word used by the ancients to express a bean decorticated and broken into small pieces, in order to be boiled in ptisans; and also applied indifferently to all the leguminous fruits broken in the same manner.

EREKLI, in *Geography*, a town of Asiatic Turkey, in the province of Caramania; 60 miles E. of Cogni.

EREMEGIKE, a town of Asia, in Thibet; 25 miles S. of Tourfan.

EREMIT. See HERMIT.

ERES, or ERIS, in *Geography*, a town of Persia, in the province of Schirvan, on the borders of Armenia; 80 miles S.W. of Derbend, and 120 S.E. of Teflis.

ERESIA, in *Botany*, a name given by Plumier to a new American genus, Nov. Gen. 8. t. 25, in honour of the Grecian botanist Theophrastus Eresius; but Linnæus, and all succeeding writers, have, with the greatest possible propriety, called the plant *Theophrasta*, which see.

ERESMA, in *Geography*, a river of Spain, which runs into the Duero, between Simancas and Tordefillas.

ERESÓS, in *Ancient Geography*, a town of the island of Lesbos, which was the native place of Theophrastus.

ERESUS, or EBUSUS, a town of the island of Ebusus, founded by a colony of Carthaginians. Its harbour was commodious, its walls very large, and its houses well built.

ERETENUS, a river of Italy, in Venetia, famous, according to Ælian, for its excellent eels, and supposed to be the present Retona.

ERETHISMUS, (from ερεθίζω, *to irritate*, or *excite*). Medical writers extend the general meaning of this term to every kind of irritation which has a tendency to weaken and destroy the vital powers.

In this article we intend to take particular notice of a dangerous affection of the constitution, well known among surgeons by the name of the *mercurial erethismus*.

Mr. Pearson acquaints us, that on his first succeeding to the situation of surgeon to the Lock hospital, he had occasion to remark, that almost every year one, and sometimes two instances of sudden death occurred among the patients of that charity. No cause could be assigned for these events, but the subjects were commonly observed to be men who had either nearly, or completely finished a course of mercury. Messrs. Bromfield and Williams, on being consulted by Mr. Pearson, concerning these extraordinary cases, confessed themselves ignorant of the cause, mode of prevention, and treatment, and explained, that they had never been able to detect any diseased appearances in the bodies of such persons as had died in this sudden and unexpected manner.

Mr.

Mr. Pearson at length ascertained, that these unfortunate accidents were to be ascribed to mercury acting as a poison on the system, quite unconnected with its operation as a remedy; and that its deleterious qualities were neither in proportion to the inflammation in the mouth, nor to the actual quantity of mercury absorbed into the constitution. The disordered state of the system, implied by the mercurial erethismus, comes on after a long employment of mercury, and tends to a fatal termination. According to Mr. Pearson, it is characterized by great depression of strength, a sense of anxiety about the præcordia, irregular action of the heart, frequent sighing, partial or universal trembling, a small, quick, and sometimes an intermitting pulse, occasional vomiting, a pale contracted countenance, a sense of coldness; but the tongue is seldom furred, and the vital and natural functions are not much disordered.

Mr. Pearson observes, that when these, or the greater part of these symptoms are present, a sudden and violent exertion of the animal power will sometimes prove fatal. Walking hastily across the ward; rising up suddenly in the bed to take food; or slightly struggling with some of the other patients, are circumstances noticed by the above gentleman as having commonly preceded the sudden death of such persons as have died of the mercurial erethismus.

In order to avert the perilous effects of this peculiar affection, Mr. Pearson states, that the employment of mercury is, at all events, to be discontinued, whatever may be the stage, extent, or violence of the venereal symptoms. Every consideration must yield to the great object of extricating the patient from a state of impending destruction; nor would a perseverance in the use of mercury, under these circumstances, be of any avail, in regard even to the syphilitic complaints.

The patient should be exposed to a dry, cool air, without being subjected to any more fatigue than can be avoided. Mr. Pearson contends, that sitting in a room with a window open is not sufficient, but that the patient should go into a field or garden, and live as much as possible in the open air, till the above symptoms have disappeared. This plan should be conjoined with a generous diet. In this way patients have often been sufficiently relieved in the short space of ten or fourteen days, to re-commence the employment of mercury, and to bear its exhibition effectually, without any bad consequences.

The gradual approach of the mercurial erethismus is commonly indicated (according to Mr. Pearson's account) by paleness of the countenance, a state of general inquietude, and frequent sighing: the respiration becomes quicker, sometimes accompanied with a sense of constriction across the chest; the pulse is small, frequent, and often intermitting, and there is a sense of fluttering about the præcordia. In this early stage the further progress of the mercurial erethismus may be frequently prevented by the exhibition of the camphor mixture with large doses of the volatile alkali, the employment of mercury being at the same time suspended. Also, when the stomach is not oppressed by sarsaparilla, this medicine is productive of infinite benefit to persons afflicted with the mercurial erethismus. See Pearson on the "Effects of various Articles of the *Materia Medica* in the cure of Lues Venerea," edit. 2. p. 155 to 159.

ERETRIA, in *Ancient Geography*, a town of Greece, in the Phthiotide, a country of Thessaly.

ERETRIA, a town of the island of Eubœa, situated on the sea-coast at some distance to the south-east of Chaleis, opposite to the mouth of the Oropus, which, on the continent, separates the limits of Bœotia from those of Attica. This town was probably built by the Athenians, as Strabo

says, before, but according to Herodotus, after the war of Troy. It was for a long time a considerable place, and remained in a flourishing state under the reign of Darius, son of Hytaspes. It was destroyed by the Persians in the war of Greece, but was afterwards rebuilt, became very rich, and subsisted in the time of Strabo. It was amply furnished with pictures, statues, and such ornaments. We cannot trace any remains, except a persuasion that it existed in a place called by the modern Greeks *Gravelinas*.

ERETRIA terra, *Eretrian earth*, in the *Materia Medica*, the name of a very peculiar kind of alkaline bole, dug in the Negropont, near the ancient Eretria, and once in great use as an astringent and a sudorific.

The ancient writers in medicine all mention the Eretrian earth, and Dioscorides and Galen describe two kinds of it, a grey and white. The grey is what is properly distinguished by this name, being an earth of a different kind from all the other boles. The white, though the ancients seem not to have observed it, yet was plainly, from their own descriptions, the same with the white bole armenic, though found in a different place. Hill's *Hist. of Foss.* p. 5.

The grey or genuine Eretrian earth is a fine and pure greyish white earth, moderately heavy, naturally of a smooth surface, of a friable texture, easily crumbling to pieces between the fingers, but not staining the skin in handling; it sticks firmly to the tongue, but melts to a butter-like substance in the mouth; it burns to a perfect snow-white, and effervesces violently with aqua-fortis. But what abundantly distinguishes it from all other earths is, that if a little be wetted, and drawn over a plate of brass or copper, so as to mark a line, the mark will in a little time appear blueish. This is recorded of it so early as in the writings of Dioscorides, and experiment proves it to be true. It seems plainly to be owing to an alkaline quality in the earth; this it plainly manifests by its fermenting so strongly with acids; and it is as well known that alkalines draw a blue tincture from copper.

The ancients all esteemed it a great medicine, and were particularly careful in their way of preparing it for use, by frequent washing. It is now unknown in the shops, but its highly alkaline quality, in which it is so much superior to all the earths in use, might make it worth the bringing into use again; and it may still be had in its old place, in almost any quantities.

ERETRIAC SCHOOL, in the *History of Philosophy*. See ELIAC SCHOOL.

ERETRUM, in *Ancient Geography*, a town of Italy, in the country of the Sabines, N. E. of Rome, and S. W. of Cures. Strabo precisely marks its situation, when he says that it was on the Via Salaris, and that the Via Nomentana terminated there. It was at a small distance from the Tiber, near the 18th mile stone, according to the tables of Antonine and Peutinger.

EREUATIS, a town of Asia Minor, in Lycia.

EREUM, a town in the island of Sardinia.

EREWASH-CANAL, in *Geography*, is the parliamentary name of an important line of canal navigation, which nearly divides the counties of Derby and Nottingham for about twelve miles, of which an account has been given under our article CANAL, to this it may be necessary to add, that by the act of the 20th George III. for Cromford canal, the tolls on this canal for all articles, except coals and coke, were lowered to one-half of those mentioned in the original act, it being provided that no supplies of water to the canal should be taken for the use of the Cromford canal, except at thirty feet below the summit level of this. Upon this canal the very important experiment was tried,

at Ilkerton common, of suffering the coal-owners to work their coal under the canal instead of paying large sums in order to have the same left, as the act had provided, and a great length has been thus excavated and the ground settled, with only a trifling and temporary inconvenience to the canal, in raising the banks: on the Nottingham canal the same was also successfully tried, even under the locks, on the recommendation of Mr. Thomas Walker; see *Nottingham canal*. A rail-way branch conducts from the head of this canal to Beggarlea and another to Old Brinsley collieries in Nottinghamshire; and another, constructed in 1808, to the new collieries in Cotmanbury-wood in Derbyshire.

EREZEË, a small town of France, in the department of the Sambre and Meuse, chief place of a canton in the district of Marche, with a population of 640 individuals. Its canton has a territorial extent of 272½ kilometres, 13 communes, and 4519 inhabitants.

ERFA, a town of the island of Corsica; 25 miles N.N.W. of Bastia.

ERFURT, or ERFORT, anciently called *Erpes*, or *Erpifurt*, a very old town of Germany, in Thuringia, on the river Gera, 60 miles N. by E. of Coburg. N. lat. 51° 6'. It appears to have been founded in the beginning of the fifth century. The emperor Lewis held a diet at Erfurt in the year 852. The emperor Henry I. did the same in 935, and Rudolph I. in 1289. The last diet of the empire held at Erfurt was that of the year 1566. Erfurt was not an immediate free imperial city, but it enjoyed several considerable lordships and immunities, first under the protection of the landgraves of Thuringia, then of the princes of Brunswick, and lastly, from the year 1483, of the electoral house of Saxony: but the archbishops of Mentz claiming the sovereignty over Erfurt, it was at last agreed, in 1667, that they should keep a governor in the city, on the express condition that the Protestant doctrine and worship should be respected. The professors' chairs of the university, which had been established in 1392, were allowed to be filled half with Roman Catholic and half with Protestant teachers. In 1754 an academy of sciences was founded, to which were subsequently added a botanical garden, an anatomical theatre, an astronomical observatory, a riding school, and a society of natural history. The best public libraries are those of the Jesuits, of the Scottish convent, and of the Lutheran ministry, which contained some valuable ancient manuscripts of the Hebrew bible.

The most remarkable public building at Erfurt is its cathedral church, which is reported to have been built in the year 752. Its celebrated great bell weighs 275 cwt. In more superstitious times, pilgrims used to flock to Erfurt from all parts of Germany on a particular day, to dance the *dance of Death* (*den Todtentantz*.)

At the peace of Luneville, in 1801, the city of Erfurt, its territory and dependencies, and all the rights of sovereignty possessed by the ecclesiastical elector of Mentz, or Mayence, were ceded to the king of Prussia, as part of the indemnities to which this monarch was entitled for his losses on the right shore of the Rhine. The population of Erfurt and its territory, together with the Eichsfeld, was, in 1802, reckoned at 121,200 individuals, and in the territory of Erfurt in particular, inclusive of the town, there were 3517 individuals to the German square mile. The city of Erfurt, without the garrison, contained 16,500 inhabitants.

But Prussia having declared war against France in 1806, Erfurt was one of the first towns which surrendered to the French after the unfortunate battle of Jena or Auerstädt, in October 1806. The fort of Peterberg, which protects the city, and which had always been considered as very

strong, did not even attempt a defence. At the peace of Tilsit, in 1807, Prussia was stripped of all the new acquisitions and old possessions beyond the Elbe; and Erfurt, by the conqueror's decree of the 18th of August, 1807, was to form part of the new kingdom of Westphalia. But the French emperor having had a conference with the emperor Alexander I. of Russia at Erfurt in the month of October, 1808, this city was again transferred, by way of compliment, to the Russian emperor's brother-in-law, the present duke of Saxe-Weimar, who is a member of the Confederation of the Rhine. There is at Erfurt a considerable manufacture of ribbands, which employs above 500 individuals.

ERGALIA, of *εργον, opus*, a word used by the *Alchemists*, to express that part of their treatises which explains the instruments employed in their operations.

ERGANE, in *Mythology*, the *Inventress*, an epithet of Minerva, because to her was ascribed the invention of several arts; since, besides that of the art of war, Lucian ascribes to her that of architecture; the art of spinning, of making cloth, tapestry, silk and woollen stuffs, is also ascribed to her by the ancients. She was also reckoned the first who taught man to plant and cultivate the olive. She is likewise honoured with the invention of chariots, and of the use of trumpets and the flute, &c.

ERGASIMA, a name given by Dioscorides and other of the ancients to a very foul and coarse kind of myrrh.

ERGASTERIUM, a word used by the writers in *Chemistry*, sometimes to express the whole laboratory, and sometimes that part of a furnace on which the bottom of the retort, copel, or crucible, is to rest in an operation.

ERGASTINÆ, *Εργαστιναι*, in *Antiquity*, a select number of virgins employed in weaving Minerva's peplos or robe, which was carried in procession at the Athenian festival Panathæna. See *PEPLOS*, and *PANATHANEA*.

ERGASTULUM, among the *Ancients*, a house of correction, or workhouse, where slaves, by the private authority of their masters, were confined, and kept at hard labour for some offence. It was likewise called *sophronisterium*.

ERGATIA, *Εργατια*, in *Antiquity*, a Laconian festival, in honour of Hercules.

ERGAVIA, in *Ancient Geography*, a town of Spain, in the Tarragonensis. Ptol.

ERGAICA, a town of Hither Spain, S. of Bilbilis. This appears to have been a considerable place when it was taken by Gracchus in his campaign. Several medals were struck here, which represented Augustus and Tiberius, with an ox upon the reverse.

ERGENE, in *Geography*, a river of European Turkey, which runs into the Mariza, near Demotica, in Romania.

ERGERS, a river of France, which runs into the Ill, about two miles east from Grispoltheim, in the department of the Lower Rhine.

ERGETIUM, in *Ancient Geography*, a town of Sicily. Ptol. and Steph. Byz.

ERGINUS, a river of Thrace, in the vicinity of the Athyras, which ran before Sarpedon.

ERGITIUM, a town of Italy, in that part of Magna Græcia called Apulia, situated on the Appian way, between Teanum N.W. and Sipontum S. E.

ERGOT, in the *Manege*, is a stub, like a piece of soft horn, about the bigness of a chestnut, placed behind and below the pastern joint, and commonly hidden under the tuft of the fetlock. To dis-ergot, or take it out, is to cleave it to the quick with an incision-knife, in order to pull up a bladder full of water that lies covered with the ergot. This operation is scarcely practised at Paris, but in Hol-

land is frequently performed upon all four legs, with intent to prevent watery sores and foul ulcers.

ERGOT, in *Agriculture*, is a vegetable disease which affects different sorts of grain, and other crops, shewing itself, according to the author of *Phytologia*, by the seeds growing out into large horns, having a black appearance without, as in sea-cale, rye, and in carex. It very often attacks the rye in France, and occasionally in this country in such seasons as are very moist; the grain in these cases becoming considerably elongated, being either straight or crooked, containing a black meal along with the white; and is asserted to have the appearance of being pierced or perforated by insects, which are believed by some to be the cause of the affection. It has frequently other different appellations, such as clavus, or the spur, and horn seed. No certain remedy or method of preventing it has, we believe, been yet discovered. See next article.

ERGOT, in *Medicine*, a term originally applied, as we have seen, to a peculiar disease of corn, especially of rye, from the resemblance of the grains thus affected, to the spur of a cock: and, by metonymy, used to denote a disease in the human body, occasioned by taking this diseased, or *ergoted* rye as food.

The earliest account of this disease of rye, and of its pernicious influence on the human body, with which we are acquainted, is contained in a letter from M. Dodart to the editor of the *Journal des Savans*, published in March, 1676. (See vol. iv. part ii. p. 79.) The facts were communicated a few years before by the physicians and surgeons of Sologne, in which district the disease had been very prevalent. The grains of rye, affected by the ergot, according to M. Dodart, are of a blackish colour externally, but white within, and when dry, they are harder and of a more compact substance than the natural grains, and have no bad taste. They are considerably longer than the other grains, some of them being fourteen or fifteen lines in length, and two in breadth; and seven or eight of them are sometimes seen in one ear. They are obviously not foreign substances engendered between the grains of rye, M. Dodart adds, but the true grains, surrounded with their proper coats, in which the place of the germ is discernible. These grains were called *ergots*, *spurs*, in Sologne; in Gastoins, where they also were known, they were termed *bled cornu*. In various other places this diseased rye has been called *secale cornutum*, or *corniculatum*, *secale luxurians*, *clavus secalinus*, *mater secalis*, or *mutterkorn*, (by the Germans), &c. It is stated by Tissot, on the authority of Haller, that the ergot affects rye only, or two or three other Alpine plants of the grass-kind. (See *Philos. Transact.* vol. lv. for 1765, p. 110. A minute description of the ergot was published by C. N. Langius in 1717, the substance of which may be found in the *Acta Eruditorum* for 1718, p. 309.)

The learned Tissot, in his letter to sir George Baker, just referred to, states that there are two other diseases which affect rye and wheat, and which have been confounded with each other, as well as with the ergot, or *secale cornutum*, viz. the *rubigo*, or mildew, and the *ustilago*, *bruſure*, or blight; the former being characterized by the appearance of a reddish yellow powder, of a glutinous nature, adhering to the stalk and head of the corn; and the latter by a blackness and degeneration of the corn. (See Fontana on this subject, and sir Jos. Banks on the diseases of corn.)

The ergot was particularly observed in rye in wet seasons, and more especially when a wet spring was succeeded by excessive heat. M. Dodart remarks that the bread, which was made of ergoted rye, did not differ from ordinary bread

in point of taste; that this rye was most particularly pernicious when new; but that its effects were not observed until it had been eaten for a considerable time. M. Noël affirms that it loses its deleterious qualities altogether after being kept a few months in sheaf. (See a letter in *Queſnay's Traité de la Gangrène, seche*, p. 407, Paris, 1749.) And writers in general agree in stating, that the disease, which the ergoted rye induces, is prevalent only at the conclusion of harvest, and ceases before the commencement of winter; and that it was chiefly observed among the poor, who were unable to procure wheaten bread in those seasons of humidity and scarcity. (See Muller in *Comment. Lipsiæ*, anno 1752, p. 634, &c.)

The symptoms of the ergot in the human body are described somewhat differently by different writers; but they coincide in representing a dry gangrene, and ultimately death, as the ordinary results of the disease. It commences with a lassitude and debility, but with little interruption to the functions in general. A degree of torpor in the lower extremities is then observed, accompanied, according to some of the writers, with a sense of prickling, and of the creeping of insects (*formicatio*) upon the skin; a slight degree of swelling, but without inflammation, ensues, often accompanied by the most excruciating pains, and with a sense of burning heat; soon succeeded by that of extreme cold; the skin of the feet and legs becomes shrivelled, and of a dark hue, as if dried in smoke, afterwards black and destitute of feeling; in fact the limb dies, or is gangrenous, but in a dry state, which has been compared to that of a mummy. By degrees the dead parts separate from the living, as if they had been destroyed by caustic. In this mutilated condition, deprived of one, sometimes of both legs, more rarely of the hands or arms, some individuals have survived for months, or even years.

Besides this spontaneous gangrene of the limbs, another species of disease has been ascribed to the use of *ergoted* rye by Hoffmann, Tissot, and some other writers; but with what justice or propriety may perhaps admit of a question. The disease alluded to was a febrile disease, said to be of a contagious and malignant nature, and to be accompanied and principally characterized by various spasmodic and convulsive symptoms, by which, or by a general epilepsy, the patients were frequently carried off. This disease is said to have been epidemic in Heflia, Westphalia, and other parts of Germany, at several different periods, in the 16th and 17th centuries; and a description of it by the professors of the university of Marburg, in the year 1597, is generally referred to, as the first complete account of the disease. But in that account, of which a translation is given by Gregorius Horstius, no allusion whatever is made to the ergot, or *secale cornutum*; bad bread is mentioned only among other sorts of crude and unwholesome aliment, to which the disease (occurring in a time of dearth) is there ascribed. The whole of what is said respecting the exciting causes of that epidemic is contained in the compass of these few lines. "*Causas hujus affectus quod attinet, ex ægrotantium relatione scire licet, quod externa causa communiter in alimento, ad nutriendum minus idoneo et improporcionado, consistat, dum pauperes rebus ad vitam necessariis destituti, panem impurum et male coctum longo tempore, in summâ famiâ urgentiâ, devorant, interdum etiam poma acerba et auſtera, fungosque et similia deglutientes, sese edulis crudis, immaturis, et astrigentibus ingurgitant, de quorum depravatâ concoctione cruditates obortæ, &c.*" (See Greg. Horit. *Opera*, vol. ii. lib. viii. obs. xxii.) A similar statement, respecting the origin of this epidemic, is given by Sennertus in his chapter, "*De febre Malignâ cum Spasmo*," probably

upon the authority of the Marburg professors. The disease he supposed to be excited by a malignant vapour or humour, vellicating the brain and nerves. "Malignus autem ille vapor et humor ortum habuit ex victu pravo, dum, ob annonæ caritatem, panem non bonum, fructus corruptioni obnoxius, fungos, et id genus alia, ad explendam famem, pauperes devorabant. Ex quo victu pravo vitiosos humores in corpore colligi necesse est, &c." (Sennert. de Febribus, lib. iv. cap. 16.) The disease, therefore, is obviously considered by the original writers as originating from defect of nutritious food, and the ergot is not in any way alluded to. The symptoms of this fever, which was called by the Germans *die kriebel, krankheit, oder ziehende feuche*, the convulsive pebtilence, are thus briefly enumerated by Hoffmann. "The disease in its commencement occupies the limbs and the extremities of the hands and feet, in which a sense of formication is felt. In some instances it begins with sickness and vomiting. Then follow violent spasmodic contractions of the fingers and toes, which at length also attack the knees, shoulders, elbows, and even the face, eyes, and lips, accompanied by an intolerable pain, and sometimes with a sense of extreme coldness, sometimes with that of a burning heat. These symptoms return at stated periods, and sometimes continue for several weeks. As the pains diminish, the patients fall into a state of drowsiness and torpor, often into an alienation of mind, and are affected with giddiness and deafness, the limbs remaining stiff, and destitute of the power of motion. In the extremities of the limbs large vesicles, filled with serum, often appear, and sometimes other tumours, which pass into a gangrenous condition, but by a very slow progress, by which ultimately even the bones have been gradually destroyed. A state of general convulsion, or epilepsy, occasionally supervenes, and proves fatal, especially in children." (Hoffmann. Med. Rat. vol. ii. par. ii. cap. 9. § xvi.) A more detailed account of the symptoms is given by Sennertus, loc. cit. Dr. Cullen has followed Linnæus and Vogel in denominating this disease *Raphania*; (See Amœn. Academ. vol. vi.) but questions whether it be the same disease as the *Necrosis ustilaginea*, by which term Sauvages has designated the ergot. (See Cullen. Nosol. Meth. gen. 52. Sauvage Nosol. Meth. class. x. gen. 39.) There is, in fact, much confusion in the accounts of authors upon this subject; and it seems probable that the true effects of the ergoted rye are to be found only in the dry gangrene, and not in the epidemic fevers, which have been ascribed to it.

It was long ago known that corrupted corn was poisonous to the animal body. Galen remarked, that the seeds of colium temulentum mixed with wheat, or the degenerated grain, called black wheat, would produce fever, head-ache, delirium, and gangrenous ulcers. (De Aliment. facultat. lib. i. cap. 37.) Most of the writers on the subject, from M. Dodart downwards, have stated, that the ergoted rye, when given to fowls, hogs, and other animals, as food, produces the same symptoms as in man, and destroys life. More lately the Abbé Tessier made a series of experiments upon this subject, and has given a minute description of the ergot in rye. He found that by feeding or cramming turkeys and other animals with this diseased rye, he could produce in all of them the dry gangrene and death. (See Memoires de la Soc. Roy. de Medecine for 1776, p. 303. Hist. de l'Acad. des Sciences for 1710. Acta Erudit. Lips. 170 et 1752. Saviard Obs. Chirurg. The Treatise of M. Tessier, &c.)

The dry gangrene occurs from other causes than the ergoted rye. An account of a whole family consisting of eight persons, who were seized and mutilated or destroyed

by gangrene of the lower extremities, preceded by pain and some swelling, at Wattisham in Suffolk, is given in the Philos. Trans. vol. liii. part ii. The state of the family, three months after the commencement of the disease, is thus represented: "1. Mary, the mother, æt. 40. The right foot off at the ankle; the left leg mortified, a mere bone, but not off. 2. Mary, æt. 15. One leg off below the knee; the other perfectly sphacelated; but not yet off. 3. Elizabeth, æt. 13. Both legs off below the knees. 4. Sarah, æt. 10. One foot off at the ankle. 5. Robert, æt. 8. Both legs off below the knee. 6. Edward, æt. 4. Both feet off at the ankles. 7. An infant, four months old, dead." The father also suffered slightly in the fingers. Although the symptoms were exactly those of the ergot, yet, in this case no rye was eaten, nor could any other circumstance in the diet or economy of the family be discovered, to which the gangrene could be attributed. See GANGRENE.

ERIACH, in *Antiquity*, the name of a recompense assigned by the Irish Brehon law, in case of murder, to the friends, or to the child or wife of him that was slain, as a kind of composition between the murderer and his persecutors.

ERIAMBO, in *Geography*, a river of Russia, which runs into the Oby; 30 miles above Obdorokoi.

ERIANTHUS, in *Botany*, from *εἶν*, wool, and *ἄνθος*, a flower, Michaux Fl. Boreali-Amer. v. 1. 54. A genus of grasses established by Michaux, in its character very near *Saccharum*, but more naturally allied to *Andropogon*, to which, if the character of that genus were reformed, Michaux himself suspects the present might be referred. *Andropogon* indeed seems to require a thorough investigation, and probably a division into more than two genera.

ERIBANUM, in *Ancient Geography*, a town of Italy, in Campania, upon the Vulturinus. Polybius.

ERIBŒA, a town of Macedonia, in the country of the Parthæans. Ptol.—Also, a mountain of Macedonia; in the same country.—Also, a town of Asia, in Bithynia.

ERIBOLUM, the port of Nicomedia, a town of Bithynia.

ERIC, king of Denmark, in *Biography*. There were several princes of this name, though but few of them have any claim to notice in this place. Eric the First was possessed of so many virtues that he was surnamed the "Good." A musician, celebrated for his great skill on the harp, asserted that he could deprive his hearers of their understanding by the powers of his instrument. Eric challenged him to the trial, and in the paroxysm of phrenzy into which the performer threw the monarch, he killed four of his guards. Grieved at what he had done, he made all the recompense he was able to the relations of the deceased, and to do penance for the bloody deed, he determined to undertake a pilgrimage to the Holy Land. His subjects remonstrated against his design, but he was not to be dissuaded from his purpose, set out on his journey, and died at the isle of Cyprus. This event took place in the year 1107.

ERIC X., king of Sweden and Norway, as well as of Denmark, the son of Wratislaus VII. duke of Pomerania, was declared successor to the crowns of Denmark and Norway in the year 1388, by his great aunt, queen Margaret; and when, in 1396, she annexed the crown of Sweden to her dominions, Eric was, by the treaty of the "Union of Calmar," declared successor to that also. This celebrated treaty consisted of three articles 1. "That the three kingdoms of Denmark, Sweden, and Norway, should thence forward have but one king, who should be chosen alternately by each of them, and approved in a general assembly. 2. That the monarch should divide his residence equally between the three

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three kingdoms, and appropriate the revenues of each to its particular exigencies. 3. That each kingdom should retain its own laws, customs, senate and privileges; and that the subjects of the one should not be elevated to offices of profit or power in another." These conditions seemed, at first sight, to have been dictated by wisdom, but they proved to be the source of wars that continued to rage during a whole century between the three kingdoms. On the death of the queen in 1412, Eric succeeded without opposition to the three united crowns. He had married the daughter of Henry IV. king of England, with whom he had a large portion, and thus might be regarded as one of the most potent kings of his time. Eric was soon involved in a war with the princes of Holstein, which for some time was carried on with doubtful success, but in 1424 the whole of South Jutland, including Sleswick and Gottorp, was adjudged to the Danish crown. This award, which was made by the emperor Sigismund, at Buda, determined Eric upon a pilgrimage to the Holy Land. During the expedition, he was made captive, and obliged to pay a large ransom for his liberty. His absence from home was attended with other evils. From his accession he had displeased the Swedes by refusing to call a general diet for the confirmation of their liberties, which excited much discontent, that at length broke out into open rebellion. In 1435 he met the Swedish diet at Stockholm, and agreed to a full redress of grievances. His promises, however, were of little avail to his people, who, after enduring much from his misconduct, deposed him in 1439, and chose, in his stead, his nephew Christopher of Bavaria. For ten years he made many attempts to regain his situation, but without success. After this he employed himself in compiling a history of Denmark from the public registers, comprizing the period from the commencement of the monarchy to 1288. He afterwards repaired to the isle of Rugen, where he died in 1459. Eric possessed quick natural parts, and was a lover of learning; but he was ambitious, despotic, irrefolute, and insincere, qualities which led him into many difficulties, and which rendered his reign truly disastrous. *Univer Hist.*

ERIC XIV., king of Sweden, son of Gustavus Vasa, ascended the throne of Sweden in 1560, at the age of twenty-seven, and was possessed of all the accomplishments proper to his elevated situation. He spoke the modern languages, danced gracefully, shewed animation in all his actions, and was eloquent and polite. But he suffered himself to be hurried away with gusts of passion, which sometimes obliterated every trace of reason, and rendered him furious. His father, who had witnessed these fits of rage, had once formed the design of excluding him from the throne, and of conferring the crown on his second son. For the same reason he refused to permit him to visit England to pay his court to the princess (afterwards queen) Elizabeth: but negotiated the business by means of his ambassador and second son John. Eric, however, almost immediately after his accession, determined to obtain an interview with Elizabeth, and set sail with a large fleet and splendid train, but the vessels being overtaken by a violent storm, were driven back upon his own coast, where he suffered shipwreck, and for a time relinquished his matrimonial project. He next sent proposals of marriage to Mary queen of Scotland, and almost before he could obtain any answer, solicited from the emperor the hand of the princess of Lorraine, daughter of Christian II. with whom he was enamoured by the description of some of his courtiers. He received a favourable answer, but in the mean time he had changed his mind in favour of Elizabeth. His political conduct was as capricious as his amours, and involved him in continual quarrels

with his neighbours, and a confederacy was formed against him by Muscovy, Poland, Denmark, and Lubeck. His brother John, who had married Catharine, daughter of the king of Poland, fell under his suspicion, and was driven to an open rupture. John was cited to Stockholm, to vindicate his conduct, and refusing to appear, an army was sent into Finland with orders to seize him and his wife, and to bring them to the capital. He was immediately thrown into prison, accompanied by his wife, who voluntarily chose to share in his sufferings. It is said that the king went frequently to the prison with the design of murdering his brother, but that on seeing him he felt his heart so moved with pity, as to prevent him from striking the fatal blow. Sometimes with tears in his eyes he would confess the sanguinary design which had prompted his visit, and added, "I know that the crown of Sweden is intended for you, and I request that, when you are in possession of it, you will pardon my errors." This circumstance strongly displays the violence of contending passions in the mind of Eric, and has been brought to prove his insanity.

The early years of his reign were spent in wars chiefly with Denmark, carried on with vigour on the part of Eric, though without any permanent advantage. Domestic troubles at length withdrew his attention from foreign wars, and his capricious conduct destroyed all respect for him in the breasts of his subjects. Disappointed in his matrimonial projects, he entertained a number of concubines, one of whom, a peasant's daughter, gained such an ascendancy over him that he married her. He was under the influence of his ministers and domestics of mean rank, who frequently excited his jealousies of the great families. He entertained a particular hatred of the Stures, an illustrious family, descended from the ancient regents. Eric had taken one of them into favour, though he had, on a former occasion, disgraced him, and made him contemptible in the eyes of the populace. He now sent him in the quality of ambassador to Stralsund, but he became once more the object of the king's abhorrence, who conceived that he was conspiring against his life and crown. The king took pains to convince the states that Sture carried on dangerous intrigues at Stralsund; and he suborned witnesses to accuse him of treasonable designs. An infamous favourite, named Peerfon, persuaded Eric to extirpate the whole family; sentence of death was accordingly pronounced against those unfortunate men, together with twenty-six nobles, who were the pretended accomplices of a conspiracy laid to their charge. A public trial was afterwards allowed them, in which the Stures were able to vindicate their cause so completely, and to prove their innocence so undeniably, that the king himself apologized to them for their detention and long imprisonment: nevertheless, in a very short time, he stabbed Nils Sture with his own hand. The unfortunate man drew the dagger from his breast, and presented it to the monarch, who, with the most savage barbarity, ordered his guards to accomplish that which he had failed to perform himself. The rest of the prisoners were also cruelly murdered at the same time. No sooner was this bloody scene over than Eric felt the pangs of a wounded conscience. He grew frantic, and, as if pursued by the avenging furies, fled into the woods, where he wandered for many days like a wild beast, refusing to take food or repose. On his return he endeavoured to compensate for his cruelty, by bestowing large sums upon the friends and relations of the victims; and by giving up Peerfon to the hands of justice, who was condemned but not executed. Being threatened by the king of Denmark, Eric set at liberty his brother John, to whom and to his other brother he proposed assigning lands

in Livonia, in lieu of those left them by their father Gustavus. Shortly after he formed a design of putting them to death, and of conciliating the friendship of the czar of Muscovy, by delivering him the wife of duke John, to whom that prince had paid his addresses before her marriage. His intentions were discovered in time to defeat the purpose, and the brothers began to raise forces in their own defence. Eric made a stand, and an accommodation was effected, but by the treaty he bound himself to give up Peerfon, his favourite, who, being put to the torture, confessed a plot contrived by himself and the king, of pillaging Stockholm, burning part of the ships in the harbour, and proceeding with the rest loaded with spoil to Narva. The dukes now felt themselves justified in breaking the treaty, and they obliged Eric to capitulate in the citadel. He was put under confinement, solemnly deposed by the states, and duke John elected in his stead. His children were declared incapable of succession, and himself was condemned to perpetual imprisonment. His keepers were appointed from among the relations of those whom he had cruelly massacred, and who did not fail to subject him to various insults and indignities, and not unfrequently to the evils of cold and hunger. After nine years imprisonment, he finished a wretched life in 1578, in consequence, it was supposed, of a dose of poison administered by order of his brother John, who dreaded the possibility of his being liberated, and again set upon the throne. Eric was not deficient in talents; and he possessed great personal bravery: under his conduct the Swedish troops repeatedly distinguished themselves in contending with and overcoming the Danish armies, and it has been thought that he would never have submitted to the hard conditions which Denmark at length imposed on his successor. (See JOHN.) Univer. Hist.

ERICA, in *Botany*, *ερινος* of Dioscorides, the same name, variously corrupted, being applied to the several species of this genus among the modern Greeks at present, according to Dr. Sibthorp. See *Prod. Fl. Græc.* 256, 257.—Heath or Ling.—*Linn. Gen.* 192. *Schreb.* 258. *Willd. Sp. Pl.* v. 2. 356. *Ait. Hort. Kew.* v. 2. 14. *Sm. Fl. Brit.* 417. *Mart. Mill. Dict.* v. 2. *Juss.* 160. *Gærtn. t.* 63. *Tourn. t.* 373. *Class and order, Obandria Monogynia. Nat. Ord. Bicornes, Linn. Erica, Juss.*

*Gen. Ch. Cal.* Perianth of four ovate-oblong, permanent, upright, often coloured leaves. *Cor.* of one petal, permanent, four-cleft, regular, with an ovate or cylindrical tube, more or less inflated. *Stam.* Filaments eight, capillary, equal, inserted into the receptacle; anthers cloven at the summit, opening by two pores, by which they laterally cohere while young. *Pist.* Germen superior, roundish; style thread-shaped, straight, longer than the stamens; stigma capitate, in four or eight lobes. *Peric.* Capsule roundish, smaller than the calyx, which covers it, of four cells and four valves. *Seeds* numerous, affixed to the columella.

*Ess. Ch.* Calyx of four leaves. Corolla four-cleft. Stamens inserted into the receptacle. Anthers with two pores. Capsule superior, of four cells. Seeds numerous.

*Obs.* Some species appear to have a double calyx, but the lowermost was by Linnæus latterly esteemed rather of the nature of bractæas. The shape of the corolla is extremely different in different species, its tube being in some globular, in others ovate, in others again cylindrical and much elongated; sometimes dilated at the orifice, sometimes contracted, in some instances curved. The anthers, either included within the tube or projecting beyond it, are in some simply cloven at the top, without any appendage at the base; in some this latter part bears a pair of bristles,

in others a pair of notched leaflets, termed a crest, which, as Mr. Salisbury remarks, originate rather from the filament than from the anther.

This extensive and most elegant genus is confined to Europe and the southern part of Africa, the country about the Cape of Good Hope being, of all others, most abundant in Heaths, whence the green-houses of Britain are continually supplied with new species or varieties, to the great profit of nurserymen, some of whom find it worth while to keep a collector resident there. No *Erica* is found in America, in New Holland, nor scarcely in the Torrid Zone. The habit of the whole genus is shrubby, very rarely arborescent, with small, opposite or whorled, usually narrow, leaves, and bracted stalked flowers, whose colours partake of all the most exquisite tints of red, purple, yellow or orange, occasionally variegated with green or white. Some are entirely white, but the anthers are commonly dark brown or purplish.

It is difficult to guess at the number of the real species of *Erica*. Willdenow has 137, some of which are duplicates. Our gardeners reckon about 300, many of which are merely varieties, but there are several others only known hitherto in a dried state, and probably not a few yet remain to be discovered in the wilds of southern Africa.

The greater part blossom with us in the spring, but many at various seasons. They are for the most part inodorous, though a few of them are delightfully fragrant. They commonly keep well in an herbarium, provided they are dried suddenly, so as not to throw off their leaves during the process.

Few good figures of this genus, except of the European kinds, are found in the older botanical works, but many appear to great advantage in the more recent works of Ventenat, Wendland, Curtis's Botanical Magazine continued by Dr. Sims, and especially in a folio publication by Mr. Andrews, entirely devoted to the subject, as well as an octavo one, equally useful, by the same artist. The most superb of all, however, are two thin fasciuli, published by Mr. Aiton, of coloured plates by Mr. Frederick Bauer, but unhappily without any descriptions or even specific characters.

In the scientific definition of the species of *Erica* much yet remains to be done. The labours even of Linnæus and Thunberg are very far from perfection. Mr. Salisbury, who has paid much attention to the subject, has given an arrangement of 246 species, according to their natural affinities, in the sixth volume of the Linnæan Society's Transactions, with often expressive, if not classical, specific characters, but with an unlicensed change, and frequent perversion, of names. This writer includes the Linnæan genus *Blaria*, like Thunberg, under his *Erica*, while he excludes *E. vulgaris* as a genus, by the name of *Galluna*, and separates a few species (which have an irregular calyx, and fleshy fruit, with three cells and three seeds) into another genus, named, from its large stigma, *Salaxis*. To him we are indebted for remarking that the corolla of *Erica* is permanent, which is not the case in *Andromeda* and *Meuziæsa*, and that the anthers are united laterally to each other by their pores before they discharge the pollen. He also considers all true *Erica* as having the partitions of the fruit originating from the centre of each valve.

Linnæus and his followers distribute the species of this genus into three principal sections by the structure of the anthers; first, anthers arislated or furnished with a pair of bristles at their base; secondly, anthers crested, as above described; thirdly, anthers simple, or destitute of any of those appendages. The latter are subdivided into such as have

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the anthers included within the corolla, and such as have them projecting beyond its border. All these sections are moreover separated into subordinate ones by the situation of the leaves, whether opposite, or in three, four, or more rows, or scattered, of which last *E. glutinosa* is perhaps the only example. All these characters, however combined, unfortunately prove but artificial, separating species naturally allied to or resembling each other; nor are some of them, derived from the crested anthers, or number of leaves, constant or invariable, even in the same species. Still, as no natural subdivisions have yet been suggested, we may be glad of artificial and imperfect ones in so vast a genus. Mr. Salisbury, though he disposes the species in order, according to what he conceives to be their natural affinity or resemblance, especially in the form and proportion of the corolla, has not attempted to define or characterize many subdivisions of the genus. As, however, it is very instructive to contemplate the species of such a genus in this light, and as this writer's is the only attempt of the kind, we shall give examples of each of his subdivisions in the order in which he places them. It is necessary to premise that these subdivisions are considered as having in general no peculiar connection, and that one or more species often come between two of them, almost equally distinct from both and from each other. Thus, in the very beginning, *E. scoparia*, (*E. coris folio quarta*; Clus. Hist. v. 1. 42. f. 3.)—and *E. spiculifolia*, (Sm. Fl. Græc. Sib. t. 353. Prod. v. 1. 257.); stand as distinct from each other, and from three species immediately following them, among which are *absinthoides* of Linnæus;—and *setacea*, Andrews, t. 62.—Next come *planifolia*, Linn. (Pluk. t. 347. f. 1.) and *oxycoccifolia* of Mr. Salisbury, agreeing in their ovate dilated leaves, in which they are very unlike their neighbours. Then again *strigosa*, Ait. Hort. Kew. v. 2. 17;—and *scifolia*, Salisb. (rather *scifolia*), a new species, each stand separate, as not immediately allied to any other.—We shall, in separate paragraphs, mention one or more species of Mr. Salisbury's subdivisions, noticing likewise the separate anomalous species, and introducing two or three new ones, to the best of our judgment, according to their several affinities. Many still unsettled remain in every collection.

After *scifolia* follows an assemblage of eight species. Among these is *E. pubescens*, Linn. Sp. Pl. ed. 2. 506, *pellida* of Mr. Salisbury, thus characterized by him.—Leaves three in a whorl. Anthers crested, included. Flowers terminal. Leaves linear. Sides of the calyx doubled back. Corolla two lines long, downy on both sides. Crests short.—Also *E. urceolaris*, Berg. Cap. 107. Ait. and Bau. Ic. t. 16. (*pentaphylla*, Linn.)

Then 13 species with little or no affinity to each other, among which are *arborescens* (*E. coris folio prima*; Clus. Hist. v. 1. 41.); and *Thunbergii*, Linn. Suppl. 220, Curt. Mag. t. 1214, a most beautiful species, conspicuous for its globose white tube and large deep-orange limb; very rare at present in the gardens.

Next appears a collection of eight; among which is *melanthera*; another of three, including *capitata* and *bruniades* (Andr. t. 61.); and a third of 18, amongst which are *sexfaria*, Ait. and Bau. Ic. t. 11, with *nigrita* of Linn. and Thunberg, so called from its conspicuous dark anthers, elegantly contrasted with the white corolla and calyx. This last Mr. Salisbury is pleased to denominate *volutiflora*. These three subdivisions he indicates as not so distinct or dissimilar as most.

The following section comprises five new species of Mr. Salisbury's, named by him *sabritii*, *dianthifolia*, *brevifolia*,

*chlamydisflora*, and *selaginifolia*. They have all crested included anthers, and terminal flowers.

His *pannosa*, with a woolly corolla, stands alone.

Then follow 15 species, mostly *Blarica* according to Linnæus, having but four stamens; see *BLÆRIA*. Nor can we much object to the union of these two genera, except that in so vast a tribe, we may be glad of even so slight a circumstance as number to make a genus, when there is moreover such a difference in habit as this very arrangement of Mr. Salisbury's implies. If indeed a few species of *Erica*, here and there in the different natural subdivisions, were tetrandrous, nobody would think of separating them for such a reason.

*E. nudiflora*, Linn. Mant. 2. 229. Sm. Plant. Ic. t. 57, (accompanied by two others) follows. Mr. Salisbury exults in having discovered its bractæas, which escaped Linnæus, Dryander, and the author of the present article, who in this instance readily submits to his correction. They are in the form of two or three excessively minute woolly scales, near the base of each flower-stalk.

The next five, or rather we would say seven, uniting two of Mr. Salisbury's sections, are *herbacea*, Linn. Sp. Pl. 501, Curt. Mag. t. 11, not at all different from *carnea*, Sp. Pl. 504; (this, according to Dr. Sibthorp, is the genuine *Erica* of Dioscorides, extremely common every where in Greece);—*mediterranea*, Linn. Mant. 2. 229, Curt. Mag. t. 471;—*multiflora*, Sp. Pl. 503, (Garidel. t. 32.), another beautiful native of the south of Europe, long confounded with *vagans*;—*manipuliflora*, Salisb. (Sm. Fl. Græc. Sibth. t. 352.);—*vagans*, Linn. Mant. 2. 230, (Engl. Bot. t. 3.) common on all the heaths of Cornwall, either with red, flesh-coloured, or white flowers;—*umbellata*, Linn. Sp. Pl. 501, (Ait. and Bau. Ic. t. 5.);—and lastly *nutans*, Wendland. Eric. fasc. 3. 5.—The native country of this last we know not, nor have we seen Wendland's publication. The rest of this very natural assemblage grow in Europe only.

*Filiformis* and *turgida*, Salisb. we have not ascertained to our satisfaction.

Nine species, very naturally allied, having excessively long anthers, projecting from an elongated tubular corolla, are placed next. Among these are *E. Plukenetii*; *Petiveri*; *Banksii*, Andr. t. 26; *Sebana*, Dryand. in Ait. and Bau. Ic. t. 10; &c. mostly familiar to collectors.

Nine more comprehend *imbricata*, Linn. Sp. Pl. 503;—and *flexuosa*, Andr. Eric. t. 33;—with *leucanthera*, Linn. Suppl. 223;—and *milleflora*, Berg. Cap. 96, which last name is well retained by Mr. Salisbury, in preference to the inaccurate one, *paniculata*, given by Linnæus.

An assemblage of six more contains the beautiful *baccans* Linn. Mant. 2. 233, Curt. Mag. t. 358, a good specimen of the rest.

Five following ones are supposed to be little, if at all, related. Among them are the beautiful *glauca*, Andr. t. 47, Curt. Mag. t. 580; in the same section with which the *elegans*, *ibid.* t. 966, should be inserted. The flowers of the latter are larger, and differently coloured, but they closely agree in structure with those of *glauca*.—*E. Monsonia*, Dryand. in Ait. and Bau. Ic. t. 7, (*E. Monsoniana*; Linn. Suppl. 2. 3.), one of the most magnificent of all, is placed by Mr. Salisbury, with a sign of incomplete affinity, after *glauca*.—*E. halicacaba*, Linn. Sp. Pl. 507, Ait. and Bau. Ic. t. 2, follows alone. Its corolla is of a pale uniform yellowish green.

Ten species, with a long tubular corolla and short included anthers, are needlessly, we think, divided into three parcels. These are mostly handsome flowers, very frequently to be seen in gardens. Among them are *versicolor*, Andr. t. 12, which

which comprehends as a variety his *costata*, t. 46;—*discolor* of the same author, t. 3;—*cruenta*, Ait. and Bau. Ic. t. 13;—*abietina*, Linn. Sp. Pl. 506, (*E. Pattersonia* of Andr. t. 7, and the gardeners), remarkable for its thick-set leaves and crowded golden blossoms, as well as its pulpy seed-vessel;—and *concinna*, Ait. Hort. Kew. v. 2. 23, mistaken by Andrews, t. 64, for *abietina*. For this last (*concinna*) Mr. Salisbury has, in our opinion with advantage, adopted the name *paludosa* from Hermann, which indicates its place of growth, and consequently its requisite treatment in a garden.

*E. pyramidalis*, Ait. Hort. Kew. v. 3. 491. Curt. Mag. t. 366, with two others unknown to us, constitute the next subdivision.

Then follow 12 fine plants, needlessly, we again presume, divided into two parcels. Among them are *tubiflora*; *curvisflora*; *conspicua*, Ait. Hort. Kew. v. 2. 22. Ait. and Bau. Ic. t. 12; and *sordida*, Andr. t. 56; with several often confounded with these, (for it is rather an indistinct and perhaps variable tribe,) all which contribute much to adorn our green-houses, and are in general easily cultivated.

*E. fascicularis*, Linn. Suppl. 219. Ait. and Bau. Ic. t. 6; and *E. Massoni*, Linn. Suppl. 221. Curt. Mag. t. 356; occupy a section by themselves. These are two of the most highly prized of the whole genus. The flowers of both are tipped with green.

The 12 next are, in general, scarcely less splendid, witness *pharetriformis*, Salisb. (exurgens, Andr. t. 13.);—*grandiflora*, Linn. Suppl. 223. Curt. Mag. t. 189;—and *longifolia*, remarkable for its tremulous leaves and the variation of colour in its flowers, instances of which are displayed in Andrews, t. 8, t. 20, and t. 33; likewise in Curt. Mag. t. 402. The deep scarlet is justly the most admired variety.—We cannot but think *pineae*, Andr. t. 57, must be a distinct species.

To these are nearly allied the next five, comprehending *sessiliflora*, Linn. Suppl. 222, (*spicata*, Thunb. Diff. 43. t. 4. Andr. t. 6);—*alveiflora*, Salisb. called in the gardens *gelida*, which name aptly expresses the cool aspect of its snow-white corolla tipped with pea-green, and surely ought to have been retained;—and *mammosa*, Linn. Mant. 2. 234. Andr. t. 58. (*abietina*, Schneev. Ic. t. 23.); of which a beautiful scarlet variety is most common with us, called *speciosa* in Schneevoght, t. 3, and *verticillata* by Andrews, t. 21.

Of Mr. Salisbury's *brachialis*, a solitary species, we have only seen a doubtful specimen.

Four species follow, among which are *E. Sparmanni*, Linn. Fil. Suppl. 219. Stockh. Transf. for 1778. t. 2; and the noble *cerinthoides*, Linn. Sp. Pl. 505. Curt. Mag. t. 220.

*E. cernua*, Montin Nov. Act. Upf. v. 2. 292. t. 9. f. 3. Linn. Suppl. 222, stands alone; as does Mr. Salisbury's *doliiformis*, (*mammosa*, Thunb. Diff. de Erica, ed. Salisb. 42. f. 21.)

*E. australis*, Linn. Mant. 231, not uncommon in gardens;—and *ciliaris*, Linn. Sp. Pl. 503. Curt. Mag. t. 484. follow next. These are both European species, and are immediately followed by two others, our elegant English *E. Tetralix*, Curt. Lond. fasc. 1. t. 21. Engl. Bot. t. 1014, (a name changed by Mr. Salisbury to *botuliformis*, sausage-shaped);—and his *multicaulis*, the *stricta* of Donn and Willdenow, native of Corfica.

Next comes by itself our common British *cinerea*, Curt. Lond. fasc. 1. t. 25. Engl. Bot. t. 1015, more happily, but without any necessity, altered to *mutabilis*.

*E. regerminans*, Linn. Mant. 2. 232, only known in the

Linnaean herbarium;—and *pulchella*, Andr. t. 56, occupy two separate sections.

A very distinct and natural assemblage of four species next occurs, in which are *empetrifolia*, Linn. Sp. Pl. 507, known by its oairy corolla;—and *malleolaris*, Salisb. (*empetrifolia*, Curt. Mag. t. 447.)

The four next seem scarcely to be separable from them, if we may judge by *viscaria*, Linn. Mant. 2. 321. Andr. t. 55, the only one of the four with which we are acquainted.

A difficult family of seven species, with a hoary habit, and small turgid downy flowers, is placed next, of which *tardiflora*, Salisb. (*pubescens*, Curt. Mag. t. 480.);—and *hirtiflora*, Curt. Mag. t. 481, are examples. Both are distinct from, though nearly allied to, the real *pubescens* of Bergius and Linnæus, as well as from his *parviflora*.

A somewhat similar tribe, but smooth, and with larger more bell-shaped flowers, contains ten species. Amongst them is *margaritacea*, Ait. Hort. Kew. v. 2. 20. Andr. t. 54, very pretty when laden with its pearly blossoms.

*E. Bergiana*, Linn. Mant. 2. 235, remarkable for its reflexed calyx, with two others, come next, and lead insensibly to the following section.

This comprehends *pilulifera*, Linn. Sp. Pl. 407;—*obliqua*, Thunb. Diff. 44. Ait. and Bau. Ic. t. 3;—and *phycodes*, Linn. Sp. Pl. 506. Curt. Mag. t. 443; with four more.

*E. cernua*, Andr. t. 48, stands alone, but between it and *phycodes* we would introduce a new species, communicated by Mr. G. Hibbert among the rest of his dried specimens of this genus from the Cape, and by Messrs. Lee and Kennedy from their garden, where it first blossomed in 1808. We would name it

*E. rosaria*. Leaves in four rows, obtuse, recurved, toothed. Anthers simple, included, with long pores. Corolla ovate, viscid. The leaves resemble those of *phycodes*, but are more distant and recurved. Flowers about the ends of the branches, on mostly axillary, long, viscid stalks, with two or three oblong, pellucid, concave bractæas towards their middle; the flowers droop a little, and are remarkable for their fragrant scent, resembling that of roses. The calyx-leaves are like the bractæas, and about one-third as long as the corolla, which is of a pale straw-colour, ovate, inflated, viscid, its segments obtuse, crenate, but little spreading. Stamens about the length of the calyx; their filaments purple at the summit, without any crest or appendages; anthers brown, oblong, with pores two-thirds of their length. Germen turbinate, furrowed, smooth; style twice as long as the stamens; stigma capitate, dark coloured.

*E. pulchella*, Salisb. a new species, stands alone, the author being unacquainted with its affinity to any other.

Two others, unknown to us, occupy a section with *glutinosa*, Berg. Cap. 98. Ait. and Bau. Ic. t. 17. (*Andromeda droseroides*, Linn. Mant. 2. 239.) This is a beautiful plant, with all the habit of an *Erica*, nor any thing but an occasional luxuriance of number in the parts of the flower to make it an *Andromeda*.

A very splendid and distinct assemblage follows, of six species, distinguishable by their large flowers, with a long tube, always contracted at its mouth, and more or less inflated below. The border is spreading and ornamental. Among these are *retorta*, Linn. Suppl. 220. Curt. Mag. t. 362, first found at the Cape by Masson, not by Thunberg;—*ampullacea*, Curt. Mag. t. 303;—and *Aitonias*, Curt. Mag. t. 429. This last varies a little in the size and hue of its border, but so strikingly resembles the Catalonian Jasmine, that we long ago named it *jasminea*, nor is there any occasion for the uncouth precision of *jasminiflora*.—We have still some of this tribe, which appear to be nondescripts.

Ten species with flowers of a somewhat similar form but smaller, and more slender needle-shaped leaves, constitute the next parcel. To this belongs *saffigata*, Linn. Mant. 66, of which there are several elegant varieties, named *E. Humea*, &c. in the gardens. Also *E. Muscari*, Andr. t. 1. smelling like the Musky Hyacinth, which it imitates in colour;—and *comosa*, Linn. Mant. 234, Ait. and Bau. Ic. t. 18.

A tribe more splendid in general, of nine species, succeeds. To these belong *inflata*, Thunb. Diff. 41. t. 2;—*ventricosa*, ibid. 27. t. 1. Curt. Mag. t. 350;—*lutea*, Linn. Mant. 234. Andr. t. 11;—*articulata*, Linn. Mant. 65. Curt. Mag. t. 423;—and *taxifolia*, Ait. and Bau. Ic. t. 19.

Two species, indicated as nearly related to the last, close Mr. Salisbury's list of 246 in all. These are *tetragona*, Thunb. Diff. 14. t. 4;—and *albena*, Linn. Mant. 231. Curt. Mag. t. 440.

We trust, that those who may have occasion to describe new heaths in future, will, as far as they are competent, keep the above arrangement in view, as they will find it very instructive, however they may differ from Mr. Salisbury in principles of nomenclature. To this subject we have scarcely found it necessary to advert, except occasionally, and we rather pass over in silence what we cannot approve. This botanist rejects all names of persons as applied to the species of any genus. Mr. Dryander once began a more useful reformation in such names of *Erica*, making those which commemorate a writer on the subject end in *ana*, as *Sebana*; those which apply to a collector only, in the genitive case, as *Maffoni*. The greatest and most correct information is still to be expected from this able botanist, in the intended new edition of Mr. Aiton's *Hortus Kewensis*, where the genus of *Erica* must always make a principal figure. S.

ERICA, in *Gardening*, comprehends plants of the ever-green, flowery, shrubby kind; mostly exotics; of which the species most in cultivation, according to Martyn, are: the cross-leaved heath (*E. tetralix*); the fine-leaved heath (*E. cinerea*); the double-anthered heath (*E. didyma*); the tree heath (*E. arborea*); the Spanish heath (*E. australis*); the many-flowered heath (*E. multiflora*); the Mediterranean heath (*E. Mediterranea*); the yellow heath (*E. lutea*); the purple-stalked heath (*E. halicacaba*); the bladder-flowered heath (*E. monfoncana*); the mucous heath (*E. mucosa*); the hairy-flowered heath (*E. urceolaris*); the marum-leaved heath (*E. maifolia*); the bloody-flowered heath (*E. cruenta*); the slender-branched heath (*E. rumen-tacea*); the blush-flowered heath (*E. perfoliata*); the three-flowered heath (*E. triflora*); the arbutus-flowered heath (*E. baccans*); the slender-twigg'd heath (*E. corifolia*); the crow berry-leaved heath (*E. nipetrifolia*); the woolly heath (*E. capitata*); the tube-flowered heath (*E. lubiflora*); the long-tubed yellow heath (*E. conspicua*); the honey-wort-flowered heath (*E. cerinthioides*); the tufted-flowered heath (*E. comosa*); the tall downy heath (*E. Maffoni*); the smooth-twigg'd pencil-flowered heath (*E. Plukenetii*); the downy twigg'd pencil-flowered heath (*E. Petiveri*); the early-flowered dwarf heath (*E. herbacea*); and the great flowered heath (*E. grandiflora*). But there are many other species equally deserving of cultivation.

Concerning the first of these species, it is observed by the editor of Miller's dictionary, that it is not inferior to many of the foreign heaths in the beauty and delicacy of its flowers. It is distinguished from the other British heaths not only by the flowers growing in a kind of pendulous cluster on the tops of the stalks, but by the leaves growing in fours, and forming a sort of cross.

The whole of the different species of heaths which are mentioned above, are plants of considerable beauty and elegance, but mostly tender and delicate in their habits of growth.

*Method of Culture.*—These very elegant plants must be treated in different methods, according to their nature and habits of growth.

The first three British sorts are capable of being propagated by sowing the seeds either in the places where they are to remain, or in pots filled with peaty earth, in either the autumn or spring seasons; but this is a tedious method of practice. The better method is, therefore, to take them up from the places where they grow naturally, in the early autumn, with good balls of earth about their roots, planting them again immediately where they are to grow and remain for ornament.

They are found to succeed best where the soil is of the peaty or moory kind, and where it has not been enriched by manure; and as they protrude their roots chiefly near the top, it should be as little dug about them as possible, the surface only being kept clean and free from rubbish.

And the four following sorts may be increased in the same manner as the above; but the best practice is by layers, cuttings, or slips, which should be laid down or planted out in pots filled with boggy earth either in the early spring or the latter end of summer, plunging them in a moderate hot-bed, and giving them proper shade and water. When they have taken full root, they should be carefully removed with balls of earth about them into separate pots, being replaced in the hot-bed till they become well established, when they will be capable of bearing the open air in mild weather when the season is suitable.

All the other species may be increased either by cuttings or layers, but most of them by the former. The cuttings should be made from the best young shoots, and be planted in the spring season in pots filled with a composition of light boggy and loamy earth, being placed in the hot-bed, and covered with bell-glasses, and duely shaded from the sun, slight waterings being given when necessary; the layers are best laid down in the autumn, being managed in the same way as the cuttings. When the plants have become perfectly rooted, they should be removed into separate pots filled with the same sort of mould, being then put in the dry stove or green-house, where some of them require to be constantly placed.

But the ninth, twentieth, and twenty-sixth species must be raised by layers, as they have not yet been increased by planting their cuttings in the manner directed above.

Where seeds are made use of in producing these plants, they should be sown in pots filled with the above sort of earth in the early spring, and plunged in the hot-bed of the stove. When the plants have acquired a few inches growth, they should be removed into single pots with a little earth about their roots, and be replunged in the hot-bed in the stove, being preserved in it, or the warmest part of the green-house, during the winter season, and whenever the weather is bad.

The first three sorts afford an agreeable variety in the borders and clumps, as they continue long in flower. The four following kinds are likewise hardy, and afford variety among other potted plants in the open air during the summer months.

All the other species are more tender, but produce as agreeable an effect among the stove and green-house collection, from the great beauty and continuance of the flowers in many of the sorts.

*ERICA marina, sea-heath*, a name given by many authors

to a very beautiful zoophyte of the fucus kind, called by Mr. Ray and some others the fucus ericae folio.

ERICA, in *Ichthyology*, a name given by Gaza and some others, as the interpretation of the chalcis of Aristotle, that is, as the name of the common herring.

ERICÆ, in *Botany*, the third natural order in the ninth class of the system of Jussieu, so named from the genus *Erica* which makes a part of it. This order consists of such dicotyledonous monopetalous plants as have perigynous stamens, and the following distinguishing characters. *Calyx* of one leaf, permanent, sometimes superior, more frequently inferior and deeply divided. *Corolla* of one petal, sometimes deeply divided, inserted either into the upper part of the calyx, more commonly into its lower part, or into a gland at its base; mostly withering and permanent. *Stamens* of a definite number, distinct, inserted into the same part, or rarely originating from the lower part of the corolla; anthers mostly with two horns at the base. *Germen* superior, or rarely inferior; style solitary; stigma generally simple. *Fruit* either superior or inferior, with many cells and many seeds, either pulpy, or more generally dry with many valves, fixed by their bases to the central axis, the partitions originating from the middle of each valve. *Seeds* generally minute. *Stem* shrubby, of a more or less elevation, or herbaceous. *Leaves* alternate, or opposite, or whorled.

This order is in a great measure analogous to the Linnæan *Bicornes*, exclusive of the *Rhododendra* of Jussieu, which differ from his *Erica* chiefly in having the partitions of the capsule formed of the inflexed margins of its valves, and not originating longitudinally from their centre. Ventenat retains the name of *Bicornes* for the *Erica*.

The *Erica* are divided by Jussieu into two sections, 1. *Germen* superior, consisting of *Cyrilla*, Linn. (which being of the same genus as *Itea*, and having the capsule of the *Rhododendra*, is to be removed thither); *Blaria*; *Erica*; *Andromeda*; *Arbutus*; *Clethra*; *Pyrola*; *Epigæa* (removed by Ventenat to *Rhododendra*); *Epacris* (omitted by Ventenat); *Gaultheria*; and *Brossæa* (likewise omitted by Ventenat, a very uncertain plant).

2. *Germen* wholly or partly inferior, *Argophyllum*, Forst. and Linn. fil.; *Mæsa*, Forst; and *Vaccinium*.

A third section contains two genera allied to *Erica*, or supposed to be so, *Empetrum* and *Hudsonia*.

ERICALE, from  $\epsilon\rho\sigma$ , the spring, and  $\kappa\alpha\lambda\lambda\eta$ , beautiful, a name given by Renealm in his Specimen Hist. Plant. 75. t. 68. to the *Gentiana verna*, a most elegant vernal plant. Linnæus erroneously prints it *Ericoila*.

ERICERUM, a name given by Aetius and other authors to a sort of collyrium, used in weaknesses of the eyes, in which the herb erica or heath was an ingredient.

ERICEYRA, in *Geography*, a town of Portugal, in the province of Estremadura, on the sea-coast; 20 miles N. W. of Lisbon.

ERICHTHONIUS, in *Astronomy*, a constellation, the same as Auriga.

ERICOILA, in *Botany*. See ERICALE.

ERICU, a name given in Rheede's Hortus Malabaricus, v. 2. 53. to the *Asclepias gigantea*. It is corrupted from the Sanscrit name *Roey*.

ERICUSA, in *Ancient Geography*, one of the seven Æolian islands, now *Alicuda*.

ERIDANUS, in *Astronomy*, a constellation of the southern hemisphere, in form of a river.

The stars in the constellation Eridanus, in Ptolemy's Catalogue, are 34; in Tycho's, 19; in the British Catalogue, 54. See CONSTELLATION.

ERIDANUS, in *Ancient Geography*, a river of Italy, in Cisalpine Gaul, now the Po, which see. Virgil describes it as the largest river of Italy, calling it the king of rivers:

“Fluviorum rex Eridanus.”

—Also, a small river of Greece, in Attica, which pursuing its course to the W. of Athens, united with the Ilissus below that city.—Also, a river of Celtica, near the Pyrenæes.

ERIE, FORT, in *Geography*, a strong fortification in the township of Bertie, Upper Canada, situated on the N. shore of lake Erie, at its eastern extremity, and the W. bank of Niagara river; 27 miles S. by E. from Niagara fort, 18 above the carrying place of the Falls of Niagara, and 45 from fort Chippeway. This is a small stockaded fort, somewhat similar to that at Chippeway; and adjoining it are extensive stores as at Chippeway, and about half a dozen miserable little dwellings. It has a barrack for troops and a block house; and a company of soldiers is quartered here for the purpose of transporting the public stores. The lake narrows here into the Detroit strait, which carries the waters over the great falls of Niagara. The new fort is projected on a small height in the rear of the present garrison. The harbour is capable of accommodating vessels of any size, which lie opposite to the fort, at the distance of about 100 yards from the shore, exposed to the violence of the westerly winds; but the anchorage is good, and they ride in perfect safety. The little fort, with the surrounding huts built on the rocky shore, the vessels lying off at anchor before it, the rich woods, the distant hills on the opposite side of the lake, and the vast lake itself, extending to the farthest part of the horizon, altogether form an interesting and beautiful scene. N. lat. 42° 53' 17". W. long. 78° 20' 30".

ERIE, Lake, called also *Eric*, *Erige*, or *Erike*, or the lake of the Cat, is a lake of the fourth magnitude in North America, through which runs the line between the United States and Upper Canada. Detroit river on the west brings the waters of the great lakes with which lake Erie has a communication on the north-west; and Niagara river on the east forms its communication with the waters of lake Ontario and the river St. Lawrence. It is situated between 41° and 43° N. lat. and between 78° 48' and 83° W. long. It is of an elliptical form, being about 300 miles in length, and about 90, at the widest part, in breadth. The depth of water in this lake is not more than 20 fathoms, and in calm weather vessels may securely ride at anchor in any part of it; but when stormy, the anchorage in an open part of the lake is not safe, the sands at the bottom not being firm, and the anchors being apt to lose their hold. At this time the water becomes turbid, by the washing up of the yellow sand from the bottom of the lake; but in calm weather it is clear, and of a deep greenish colour. The northern shore of the lake is very rocky, which is also the case with the shores of the islands, of which there are several clusters towards the western extremity of the lake; but along most parts of the southern shore there is a fine gravelly beach. The height of the land bordering the lake is very unequal; in some places long ranges of steep mountains rise from the very edge of the water; in others, the shores are so flat and so low, that when the lake is raised a little above its usual level, in consequence of a strong gale of wind setting in towards the shore, the country is deluged for miles. To the very great insularity of the height of the land on both sides of it, is attributed the frequency of storms on this lake; the coast, however, on both sides, is generally favourable for the passage of batteaux and canoes. A peninsula, called Longpoint, runs upwards of eighteen miles into

the lake, and being composed of sand, is convenient for hauling boats upon it, when the lake is too rough for sailing and rowing. Towards the south side, however, on both sides of the lake, it would be impossible to land, on account of the perpendicular height of the rocks. There is a great deficiency of good harbours along the shores of this lake: on its northern side there are but two places which afford shelter to vessels drawing more than seven feet water, *viz.* Long Point, and Point Abineau, and these afford only a partial shelter. On the southern shore, the first harbour you come to in going from fort Erie is that of Presqu'ete, which is situated at the distance from that fort of about six miles, and where vessels drawing eight feet water may ride in perfect safety. Beyond this, about midway between the eastern and western extremities of the lake, there is another harbour, capable of containing small vessels at the mouth of Cayahoga river, and another at the mouth of Sandusky river, which falls into the lake within the N. W. territory of the States. British ships seldom use these harbours, but trade almost solely between fort Erie and Detroit river, and in case of contrary winds, they return to fort Erie, if bound to Detroit river; or to some of the bays amidst the clusters of islands situated towards the western extremity of the lake, if bound to fort Erie. The navigation of this lake is very uncertain; and vessels are often detained, at a considerable expence to passengers, in some of the harbours. Lakes Huron and Michigan afford communication with lake Erie, by vessels of eight feet draught. There are portages into the waters of this lake from the Wabash, Great Miami, Muskingam, and Alleghany, from two to sixteen miles. The islands at the western end of the lake, of various sizes, lie very close to each other, and exhibit a very pleasing scenery; the largest of them are not more than fourteen miles in circumference, and many of them are very small. The largest islands produce a variety of fine timber, amongst which are found oaks, hickory trees, and red cedars, which latter, being large, are sent for even from the British settlements on Detroit river, at the distance of forty miles. Lake Erie has a great variety of fine fish, such as sturgeon, eel, white fish, trout, perch, &c. Amongst the woods are found racoons and squirrels, and also bears, in the winter season, when the lake is frozen between the main land and the islands. All the islands are dreadfully infested with serpents, and on some of them rattlesnakes are so numerous, that in the height of summer it is dangerous to land. Two kinds of rattlesnakes are found in this part of the country; the one is of a deep brown colour, clouded with yellow, about thirty inches in length, which frequents marshes and low meadows, and does great mischief among cattle: the other sort is of a greenish yellow colour, clouded with brown, and nearly twice the size of the former. Many different kinds of serpents, besides rattlesnakes, are found on the islands in lake Erie. The ponds and marshes in the interior parts of these islands abound with ducks and other wild fowl, and the shores swarm with gulls; among the woods are a few small birds, remarkable neither for their song nor plumage. *Weld's Travels, vol. ii.*

**ERIE**, a county of Pennsylvania, on the south side of lake Erie, containing 639,400 acres, and 1468 inhabitants. Its chief town is Erie.

**ERIEUX**, a river of France, which runs into the Rhone, at Beauchastal.

**ERIFFS**, a name given to canary birds when about two years old. See **CANARY BIRD**.

**ERIGENA**, **JOHN SCOTUS**, in *Biography*, who flourished in the ninth century, was probably born in Ayrshire Scot-

land, though some writers make him a native of Herefordshire, in England, and others suppose his birth-place to be Ireland. He possessed an ardent thirst for literature, and spared no pains in rendering himself accomplished in the learning of the East, and from the extent of his erudition he obtained the name of "Scotus the Wise." He studied some years at Athens, and became very conversant in Greek philosophy. Upon his return, he accepted an invitation from Charles the Bald of France, and lived for several years in habits of intimacy and familiarity with his royal patron, who assigned to him the direction of the university of Paris. To the sovereign he was not only an instructor in literature and science, but an adviser in the affairs of government. The high rank which he obtained excited much jealousy, particularly among the bigotted priests, who accused him of maintaining heretical opinions. In the year 824, the Greek emperor, Michael the Stammerer, sent to the Western emperor, Lewis the Pious, a copy of the treatises of the supposed Dionysius the Areopagite, which had long been held in great veneration among the Greek Christians. Dionysius was supposed to be the first Christian teacher in France, and, on that account, the work in question was deemed of great value, and the king, who was unable to read the original Greek, employed Erigena to translate it into the Latin language. Unfortunately this was performed without licence from the pope, who, when he found the translation eagerly read, insisted that the French king should not only banish Erigena from Paris, but should send him to Rome. Charles refused to act in this ungenerous manner, nevertheless, it was deemed advisable, that Erigena should leave the capital of France, and in a short time after he took refuge in England. This translation of Dionysius's treatises is said to have caused the revival of the knowledge of the Alexandrian Platonism in the West, and to have laid the foundation of the mystical system of theology which afterwards so generally prevailed. Of the original works of Erigena, the principal was his treatise "On the Division of Nature, or the Nature of Things," which was published from the author's MS. by Dr. Thomas Gale, at Oxford, in 1681, under the title of "Joannis Scoti Erigena de Divisione Naturæ, Libri quinque, diu desiderati." Erigena was employed by our great king Alfred in the restoration of learning at Oxford, where he was appointed professor of mathematics and astronomy. In this situation he remained only about three years, when some differences that took place in the university obliged him to retire to the abbey of Malmesbury in Wiltshire, where he opened a school. Here, it is asserted, by most writers, that he was murdered by his own scholars, either on account of his harshness and undue severity; or at the instigation of the monks, who hated Erigena as being a heretic, and much more learned than themselves. The particular time and place of his death have been the subjects of some dispute. Certain writers contend that his death took place about the year 864 or 865, and others, who are generally followed, make it in 883. Some say he died in England, and others, among whom is Dr. Henry, think that it happened in France. He was certainly a very extraordinary man for the times in which he lived, and after his decease his name was, for a considerable time, to be found in the list of the saints of the Romish church, till it was struck out of the calendar, on account of the heterodoxy of his opinions concerning transubstantiation. *Biog. Brit. Enfield's Hist. Phil.*

**ERIGENS PENIS**. See **ERECTOR**.

**ERIGERON**, in *Botany*,  $\epsilon\rho\iota\gamma\epsilon\rho\omega$  of the ancient Greeks, from  $\epsilon\rho\iota$ , the spring, and  $\gamma\epsilon\rho\omega$ , an old man, because it is hoary in the spring. *Linn. Gen. 422. Schreb. 553. Willd. Sp.*

Pl. v. 3, 1952. Sm. Fl. Brit. 876. Mart. Mill. Dict. v. 2. Juss. 180. Gærtn. t. 170. Class and order, *Syngenesia Polygamia-superflua*. Nat. Ord. *Compositæ discoideæ*, Linn. *Corymbifera*, Juss.

Gen. Ch. *Common calyx* oblong, cylindrical, imbricated; scales awl-shaped, erect, gradually longer, nearly equal in breadth. *Cor.* compound, radiated; *florets* of the disk all perfect, tubular, funnel-shaped, with an equal five-cleft limb; those of the radius female, ligulate, linear, awl-shaped, erect, for the most part entire. *Stam.* (in the tubular florets) Filaments five, capillary, very short; anthers forming a cylindrical tube. *Pist.* (in the tubular florets) Germen minute, crowned with hairs longer than its own corolla; style thread-shaped, the length of the hairs; stigmas two, oblong, revolute: the female or ligulate florets differ in having their corolla about as long as the hairs, and very slender stigmas. *Peric.* none, except the closed permanent calyx. *Seeds*, in the florets of the disk as well as of the radius oblong, small. *Down* long, capillary. *Recept.* naked, flat.

Obf. Dillenius observes that the innermost or central florets of the disk are generally males. One species has those of the radius destitute of a corolla.

Eff. Ch. Receptacle naked. Down simple. Florets of the radius linear, very narrow, numerous. Calyx imbricated.

This genus comprehends several plants called *Conyza*, *Virga-aurea*, *Aster*, and *Senecio* by former writers, but is a very natural one, characterized by the erect very narrow florets of its radius, usually coloured blue or white. The latest edition of Linnæus has 22 species, Willdenow 32. Three are natives of Britain.

1. *E. canadense*, Engl. Bot. t. 2019. "Stem hairy, panicled. Leaves lanceolate; the lower ones toothed."—To all appearance perfectly wild in Glamorganshire, (Mr. Middleton), though supposed by Ray to have come over from North America, where it abounds. It is an annual plant, of mean appearance, with innumerable small flowers, whose radius is white or pale red, their disk yellow.

2. *E. acre*. Engl. Bot. t. 1158. Curt. Lond. fasc. 1. t. 60. "Stem racemose. Stalks mostly single-flowered. Leaves lanceolate or tongue-shaped, sessile."—Common on a dry gravelly or chalky soil, flowering in July and August. The flowers are larger and fewer than in the former; their radius blue. Root biennial.

3. *E. alpinum*. Engl. Bot. t. 464. "Stems almost single-flowered. Calyx slightly hairy. Radius spreading."—Found in moist parts of the highland mountains of Scotland, flowering in July. This has seldom more than one flower on a stem, which is much larger than in *E. acre*, with a longish blue radius, which spreads more than is consistent with the generic character, and, perhaps, might authorize the removal of this species to *Aster*, where Linnæus originally placed it near ally *E. uniflorum*, Fl. Lapp. u. 307. t. 9. f. 3.

ERIGONUS; in *Ancient Geography*, a river of Macedonia, which, according to Livy, ran from Illyria through Pæonia into the Axios; called *Erigon* by Strabo and Ptolemy.

ERINACEA, in *Botany*, Tourn. Inst. 646, see ANTHYLLIS, sp. 15. Tournefort established it as a genus, (distinct from his *Genista-Spartium*, which consists of *Ulex* and the prickly *Genizæ*.) merely because the bush is all over armed with prominent strong spines, like a hedge-hog.

ERINACEUS, a name given by Dillenius and Micheli to a genus of *Fungi*. Linnæus, perceiving the inconvenience and absurdity of adopting a generic denomination, already

universally appropriated to an animal, changed it to *Hydnum*.

ERINACEUS, in *Zoology*, a genus of the *Feræ* order, the hedge-hog of English authors. This tribe is distinguished principally by the teeth. The fore-teeth in the upper jaw are two, and distant, in the lower two approximate; the tusks in the upper jaw five each side, in the lower three; grinders four each side above and beneath; body above covered with spines.

Species.

EUROPÆUS. Ears rounded; nostrils crested. Linn. Fn. Suec. *Erinaceus auriculis erectis*, Briff. *Echinus terrestris*, Geln. *Igel*, Knorr. *Herisson*, Buff. *Common hedge-hog*.

The common hedge-hog, or as it is sometimes called erroneously the European hedge-hog, appears to be a native of the temperate parts of Asia, and to be found in Madagascar as well as Europe. It lives in thickets and bushes, forming a nest of moss, grass, or leaves, of large size. When disturbed it rolls itself up into a globular form, presenting on every part a formidable armament of spines, and this is indeed its principal means of defence; upon being immersed in cold water it expands, and swims with perfect facility. During the winter it is supposed to remain in a state of torpidity.

Vegetables of various kinds, as the roots of plants, or fruits, reptiles, small birds and insects, constitute the principal food of this animal; the Calmucs tame and keep it in their dwellings like the cat; and in this respect they become useful, as they destroy the cockroaches, and other obnoxious insects. They produce from three to five young at a birth. The flesh is very indifferent, yet is spoken of among the old writers as an article of food, with instructions for roasting or otherwise preparing it for the table.

The hedge hog is considered as an inoffensive animal, notwithstanding the vulgar supposition, that it sucks the teats of cattle by night, and occasions ulcerations in those tender parts with the irritation of their prickles. The animal has a musky smell. Length ten inches.

INAURIS. Without external ears. Linn. Seba. *Gaiana hedge-hog*.

Length eight inches. Inhabits South America. The head is thick, short; spines cinereous tinged with yellow; hair soft, whitish chestnut over the eyes; tail short; claws long and crooked. Described on the authority of Seba.

AURITUS. Ears oval, long. *Auriculis ovalibus longis, naribus cristatus*, Pallas. Nov. C. Pet. *Siberian hedge-hog*.

Inhabits the lower parts of the Volga and Ural and extends from thence to the eastern parts beyond the lake Baikal. Its form resembles that of the common hedge-hog, but is smaller, the eyes larger, whiskers disposed in four rows; the feet longer, more slender; tail shorter, conic, annulated, and nearly bald. The female is said to breed twice a year, and to produce from four to seven each time.

MALACENSIS. Ears pendulous. Briff. *Hystrix brachyura*, Linn. *Porcus aculeatus*, f. *Hystrix malaccensis*, Seba. *Malacca hedge-hog*.

Extremely allied in its general appearance to the porcupine, and referred to the hedge-hog tribe chiefly on account of the number and arrangement of the teeth. Its size is supposed to be equal to that of the common porcupine. This animal is said to inhabit Asia, and to produce the precious stone called Piedra del Porco, the imaginary virtues of which are so highly extolled in the old materia medica.

SETOSUS. Ears shorter; top and hind head and shoulders beset with spines; tail very short and spinous. *Erina-*

*ceus fetosus*, Gmel. Schreber. *Tendrac*, Buff. *Petit tendrac de Madagascar*. Sonner. *Asiatic hedge-hog*.

Native of India and Madagascar; length six inches; wallows in the mire, and grunts like a hog, and forms burrows. Remains torpid for six months, during which the hair falls off.

**ECAUDATUS**. No tail; snout very long and acute. Schreber. *Tanrec, et le jeune tanrec*, Buff. *Madagascar hedge-hog*.

Inhabits India and Madagascar. In habit resembles the former, but is larger, measuring in length eight inches. The mouth and eyes are small; ears rounded and longer than in the fetosus; the spines black, and covering the whole back and sides; hair yellowish and feet tawny.

The two last mentioned animals are considered by Pennant as the same species, on the presumption that the former is the adult state, the other in a less advanced stage of growth. Dr. Shaw seems inclined to adopt this supposition. There, nevertheless, appears in our mind no plausible reason for such conjecture, unless the descriptions be defective in the most essential particular; for, if one has a tail and the other none, they must be distinct. That the animal described by Buffon had not obtained its full growth is rendered extremely probable by the explanation afforded, but the production of a tail cannot be supposed to depend on the age of the animal. The tanrec feeds on fruits, and remains torpid during about three months of the year.

**ERINÆI**, in *Ancient Geography*, a people of Asiatic Sarmatia. Ptolemy.

**ERINDES**, a river of Asia, towards Hyrcania or Sparta, according to Tacitus.

**ERINEUS**, one of the four cities of Doris, situate on the most northern verge of the kingdom, near the foot of the hills which part Doris from Macedonia.—Also, a port of the sea of the Peloponnesus, in Achaia, between Ægium and the promontory Rhium. Pliny.—Also, a river of Sicily, according to Thucydides, called *Orinos* by Ptolemy.

**ERINGO**. See **ERYNGO**.

**ERINNA**, in *Biography*, a Greek poetess, mentioned by different writers as a native of Lesbos, of Teios, of Rhodes, and of Tenos in Laconia, is supposed to have been contemporary with Sappho, about the year 600 B.C. but she is placed by the Chronicle of Eusebius 250 years later. She was celebrated in ancient Greece, and several epigrams were written upon her, one of which speaks of her as inferior to Sappho in lyrics, and superior in hexameters. Some fragments are extant in her name, which are inserted in the "Carmina Novem Poetarum Fœminarum." Antw. 1568. Voff. Poet. Græc.

**ERINUS**, in *Botany*, a name adopted by Linnæus from Dioscorides, the etymology of which is unknown. Neither is his *erinus*; the same with the Linnæan plant, but rather, we presume to think, something which has hitherto eluded the sagacity of commentators. His description accords in some points with *Samolus Valeranci*.—Linn. Gen. 3187. Schreb. 47. Willd. Sp. Pl. v. 3. 332. Mart. Mill. Dict. v. 2. Juss. 100. Gært. t. 55.—Class and order, *Didynamia Angiospermia*. Nat. Ord. *Personate*, Linn. *Pediculares*, Juss.

Gen. Ch. *Cal.* Perianth in five deep, lanceolate, erect, nearly equal, permanent segments. *Cor.* of one petal, unequal; tube cylindrical, somewhat ovate, the length of the calyx, reflexed; limb flat, in five deep, nearly equal, inversely heart-shaped segments. *Stam.* Filaments four, very short, within the tube of the corolla; two of them (the uppermost) a little longer than the others; anthers small. *Pist.* Germen nearly ovate; style very short; stigma capitate. *Peric.* Capsule ovate, invested with the calyx, of two cells

and two valves, the latter cloven half way down when ripe; partition double. *Seeds* numerous, small. *Recept.* compressed.

Ess. Ch. Calyx of five leaves. Limb of the corolla in five, nearly equal, notched segments. Capsule of two cells. *Seeds* numerous.

Obs. By an unaccountable error in the Ess. Char. in all the editions of Linnæus the upper lip is said to be very short and reflexed, though the whole limb of the corolla is justly described as (nearly) equally five-cleft. Willdenow copies this, though the Hortus Kewensis had corrected it.

*E. alpinus* is the best-known species. "Flowers racemose. Leaves spatulate."—Linn. Sp. Pl. 878. Curt. Mag. t. 310. Native of the alps of Switzerland, and the Pyrenean mountains, flowering in the middle of summer. It forms tufts, with several dwarf stems, bearing numerous purple flowers, and is a very ornamental plant for rock-work, requiring protection against severe frost and excessive moisture, like most alpine rock plants. It is increased by parting the roots, or by seed.

*E. africanus*. "Flowers axillary, sessile. Leaves lanceolate, slightly toothed."—Linn. Sp. Pl. 878. (*Lychnidea villosa, foliis ex alis floriferis, &c.*; Burm. Afr. t. 50. f. 1.) Native of the Cape of Good Hope. This has a taller, more branched stem, more oblong leaves, and axillary flowers, of what colour we know not, with a very long slender curved tube. It has not yet appeared in our gardens.

*E. capensis*. "Flowers spiked. Leaves linear, toothed."—Linn. Mant. 252, excluding Burman's synonym. Gathered by Sparrmann in sandy ground at the Cape of Good Hope. This is also a stranger to our gardens. The flowers are said to be yellow and very fragrant. In the dried plant they are black. The tube is an inch and half long; the segments of the limb deeply cloven, the lobes dilated, obtuse and divaricated.

*E. fragrans*. "Leaves lanceolate-oblong, toothed. Segments of the limb undivided."—Ait. H. Kew. v. 2. 357. (Selago *Lychnidea*; Linn. Sp. Pl. 877. *Lychnidea villosa, foliis oblongis, &c.* Burm. Afr. t. 49. f. 4.) Native of the Cape, rarely seen in our green-houses. The flowers are yellow or brownish, and fragrant.

*E. trivilis*. "Leaves oblong, cut, toothed. Segments of the limb slightly cloven."—Linn. Suppl. 287.—Found by Thunberg at the Cape. The flowers are said to be sweet-scented, and of a dull colour.

*E. peruvianus* and *laciniatus* of Linnæus, are both nearly related to *Verbena Aubletia*, and the former at least seems to be the very same species.

**ERIOCALIA**, from *εριον*, wool, and *καλια*, a nest, in allusion to the singularly woolly involucre in the midst of which the flowers are seated as in a bird's nest. Sm. Exot. Bot. v. 2. 37. Intr. to Bot. 373. (*Aëtinotus*; Labillard. Nov. Holl. 67.) Class and order, *Pentandria Digynia*. Nat. Ord. *Umbellæ*.

Gen. Ch. *Umbel* simple, of many short rays. *Invol.* of many lanceolate, equal, undivided, coloured leaves, longer than the rays of the umbel, and densely clothed with wool. *Cal.* Perianth superior, in five deep, equal, concave, sometimes coloured, externally hairy, permanent leaves. *Cor.* none. *Stam.* Filaments five, about as long as the calyx, equal, awl-shaped; anthers roundish, of two lobes. *Pist.* Germen inferior, obovate, compressed, furrowed, very hairy; styles two, capillary, spreading, longer than the stamens; stigmas simple. *Peric.* Fruit ovate, obtuse, compressed, furrowed, hairy, crowned with the calyx and styles. *Seed* solitary?

Ess. Ch. Umbel simple. Involucre of many lanceolate,

late, equal, woolly, coloured leaves, longer than the umbel. Fruit compressed, hairy. Petals none. Many flowers abortive.

This New Holland genus bears the most striking analogy to the European *Afrantia*, from which it differs in its woolly, not smooth, involucre, but more essentially in having no petals, and in its hairy, not muricated, fruit. M. Labillardiere had, unknown to us, previously named it *Acinotus*, but that name being already long ago occupied in mineralogy, is untenable in botany.

The only species known are two.

1. *E. major*. Sm. Exot. Bot. v. 2. 37. t. 78. (*Acinotus helianthi*; Labill. Nov. Holl. 67. t. 92.) "Segments of the leaves bluntish, flat, woolly on both sides. Flower-stalks somewhat corymbose."—Native of the sandy country about Port Jackson, New South Wales, as well as of the west coast of New Holland, flowering in October. The root appears to be annual; it is woody and branching. Stem solitary, about two feet high, erect, leafy, round, woolly, but little branched except at the upper part, where the long flower-stalks, more or less numerous, grow in a corymbose form. Leaves alternate, stalked, three-cleft, lobed and pinnatifid; their segments spreading, linear, entire, flat, a little dilated upward, and bluntish; clothed with dense wool, whiter beneath. Stipules none. Flowers terminal, large and ornamental, all over white with a green or rufous tinge. Involucre of eight or ten spreading leaves, each an inch or more in length, peculiarly soft and pliable, like velvet. Flowers very numerous, forming a convex compact sort of disk, those of the circumference males. Calyx whitish, so as to resemble petals. No aromatic or pungent flavour is perceptible in any part of the plant.

2. *E. minor*. Sm. Exot. Bot. v. 2. 39. t. 79. "Segments of the leaves acute, revolute; smoothish above; silky beneath. Flower-stalks scattered."—Found near Port Jackson, in a sandy or gravelly soil, flowering in March.—Much smaller than the last, and bearing the same analogy to it that *Afrantia minor*, Sm. Exot. Bot. t. 77, does to the *major*, t. 76.—Root woody, branched, perhaps perennial. Stem a foot or two high, much branched, leafy, round, clothed with close-pressed hairs. Leaves on long foot-stalks, divided into three or five deep, spreading, dilated, acute, revolute, pinnatifid or three-cleft lobes; green, smooth, or slightly hairy, above; densely clothed with white silky hairs beneath. Flowers on long, solitary, terminal, naked stalks, scarcely a quarter so large as in the other. Calyx green, and not coloured. Involucre almost naked underneath; hairy, somewhat silky, white or reddish above. This species is likewise without any peculiar flavour.

ERIOCAULON, from *εριον*, wool, and *καυλος*, a stem, because of the woolly or hairy stalk, which however is rarely the case. Linn. Gen. 40. Schreb. 56. Willd. Sp. Pl. v. 1. 485. Sm. Fl. Brit. 1009. Juss. 44. Gærtn. t. 83.—Class and order, *Monoclea Triandria*, Smith. (*Triandria Trignia*, Linn.) Nat. Ord. *Junci*, Juss.

Gen. Ch. Common calyx globose, depressed, imbricated, many-flowered; its scales lanceolate or obovate, obtuse, scariose, equal, permanent; perianth inferior, of two or three obtuse, permanent, muricated leaves. Male flowers several, in the middle of the disk. Cor. funnel-shaped; tube about as long as the calyx; limb in two deep, obtuse, muricated lobes. Stam. Filaments three or four, equal, inserted into the tube of the corolla, and rather longer than the limb; anthers vertical, roundish, of two lobes. Pist. Germen obsolete; style capillary, cloven; stigmas blunt. Female flowers several, in the circumference, between the calyx-scales. Cor. inferior, of two oblong, concave, obtuse

petals, muricated at the upper part externally. Stam. none. Pist. Germen superior, of two or three lobes; style thread-shaped, shorter than the corolla, cloven; stigmas two or three, acute. Peric. Capsule roundish, of two or three lobes, with as many cells and valves. Seeds solitary.

Ess. Ch. Common calyx of many leaves, many-flowered; perianth superior, of two or three leaves. Male flowers central. Corolla of one petal, cloven. Female fl. in the margin. Corolla of two petals. Stigmas two or three. Capsule of two or three cells. Seeds solitary.

The characters of this genus were so ill defined in the works of Linnæus, that Hudson conceived our British *Eriocaulon*, confounded by Linnæus with his *decangulare*, must be a distinct genus, and he therefore called it *Nafmythia*, in honour of sir James Nafmyth, baronet; see Fl. Angl. ed. 2. 414. As however no genus can be more natural and distinct than *Eriocaulon*, and the fault appears to have been entirely in the descriptions of authors, its characters are now reformed. The above description is made from the only British species, *E. septangulare*, With. 184. Sm. Fl. Brit. 1010. Engl. Bot. t. 733.—"Stalk with seven angles. Leaves sharp-pointed, with an internal network of cells. Male flowers with four stamens." It grows in several lakes in the isle of Skye very abundantly, and was found in September 1801 by Dr. Wade, decorating the edges of all the lakes in Cunnamara, in the county of Galway, Ireland. The root is perennial, consisting of abundance of simple, white, shining fibres, composed internally of a series of cells, frequently interrupted by transverse partitions, which is the general structure of the whole herb. Stalk a span high, solitary, upright, simple, naked, twisted, with seven angles and as many intermediate furrows, smooth, (so that in this instance the generic name does not well apply), invested with a tubular sheath at the base. Leaves numerous, radical, sword-shaped, smooth, taper-pointed, about two inches long. Head of flowers terminal, solitary, hemispherical, about three lines broad, prettily variegated with dark purple and white, the calyx and anthers being of the former colour, as well as a few spots on the white corolla. The snow-white club-shaped protuberances, with which the extreme parts of the calyx and corolla are muricated, give the whole an elegant feathery aspect.

Linnæus knew about five species of *Eriocaulon*, but very imperfectly, and he was cautious of adopting Dr. Hope's accurate generic description of the above plant, published in the Philosophical Transactions, v. 59. 243. t. 12, lest it should not accord with every species. As far as subsequent examination of the several exotic ones has gone, it is found to confirm the account here given. Willdenow enumerates eight species in all; Lamarck describes 12 in his Encyclopædie, v. 3. 274—277, and figures 4, rather imperfectly, in his t. 50. This last author is, nevertheless, the best we have on the subject, though Willdenow hesitated to follow him, and Vahl, in his Sp. Pl. v. 2. 210, removes his *E. spadicum*, perhaps rightly enough, to *Schoenus*.

Authors are very much confused in their accounts of the native countries of several species. The *repens* of Lamarck was gathered by Thierry de Menonville in Hispaniola, not by Commerçon in the isle de Bourbon. *E. spadicum* of the same author was found by Smeathman at Sierra Leone, from whom we have it in plenty, and whom Lamarck rightly quotes; yet Vahl mentions St. Domingo (Hispaniola) as its native country, on the authority of Lamarck's herbarium, without naming Smeathman.

The following 6 species we believe are hitherto entirely non-descript. They will probably appear, with others, more fully illustrated hereafter from the pen of Mr. R.

Brown,

Brown, when he has time to resume the study of this genus, of which we believe he has ascertained about 30 species. In the mean while, to secure his specific names and our own thus far, we shall attempt definitions of what we have determined from actual observation.

*E. pygmaeum*, Soland. MSS.—Stalks aggregate, five-angled. Leaves and sheaths rough; the latter longest. Head globose. Calyx-scales obovate, pointed.—Native of New Holland. *Herb. Linn. fil.* The stalks are about two inches high. Leaves about half an inch long, being rather shorter than the sheaths of the stalks, which is unusual. Heads brownish.

*E. scariosum*.—Stalks aggregate, five-angled. Leaves and sheaths smooth, of equal length. Head globose. Calyx-scales obovate, acute.—Communicated from New South Wales in 1792, by John White, M. D.—Stalks five or six inches high. Heads of a silvery white, scarcely so large as a pea, being about twice as big as the former.

*E. flupeum*.—Stalk nearly solitary, five-angled. Leaves and sheaths of equal length, densely woolly at the base. Head hemispherical. Calyx-scales obovate, acute. Gathered by Sonnerat at the Isle de Bourbon. Stalk sometimes above a span high. Leaves spreading, involute when dry, smooth, or nearly so, but enveloped at their base, as well as the sheath of the stalk, by a dense integument of silky wool. Head much like that of *E. septangulare*.

*E. latifolium*.—Stalks somewhat aggregate, cylindrical, furrowed. Leaves smooth, taller than the stems. Head hemispherical. Outer calyx-scales rounded, obtuse; inner lanceolate, acute.—Gathered at Sierra Leone by Dr. Afzelius. The very long and broad flat leaves, a span in length, are remarkable. The sheaths are also large, about half as long as the stalk. Head smaller than in the last, variegated with brown and white.

*E. fistulosum*. Brown MSS.—Stalks aggregate, cylindrical, striated. Leaves smooth, twice as long as the sheaths. Head hemispherical. Inner calyx-scales obovate, pointed.—Native of New Holland.—Stalks a span high. Leaves about half as long, or more, taper-pointed, smooth, rather turgid. Heads small, brownish.

*E. depressum*. Brown MSS.—Stalks aggregate, cylindrical, furrowed. Leaves smooth, as tall as the stalks. Head flattened. Calyx-scales wedge-shaped, obtuse. Native of New Holland. Stalks about two inches high. Heads hemispherical beneath, nearly flat at the top, dark purplish brown.

We have in our descriptions substituted the word stalk (*scapus* or *pedunculus*) for stem, as being more correct. S.

**ERIOCEPHALUS**, so named by Dillenius from *εριον*, wool, and *κεφαλη*, the head, in allusion to the remarkably woolly appearance, singular in the tribe to which it belongs, which this plant makes when in seed. Linn. Gen. 450. Schreb. 586. Willd. Sp. Pl. v. 3. 2384. Mart. Mill. Dict. v. 2. Juss. 186. Gært. t. 168.—Class and order, *Syngenesia Polygamia-necessaria*. Nat. Ord. *Compositæ nucamentaceæ*, Linn. *Corymbifera*, Juss.

Gen. Ch. Common calyx erect, of ten ovate, equal, cohering scales; the five outermost keeled, the inner ones flat. Cor. compound, radiated; the perfect florets doubly numerous, constituting the disk; female ones five, making the radius: that of the perfect florets funnel-shaped, with a five-cleft spreading border; of the radius flat, inversely heart-shaped, with three terminal lobes. Stam. in the perfect florets, Filaments five, capillary, very short; anthers united into a cylindrical tube. Pist. in the perfect florets, Germen obsolete; style simple; stigma cloven, acute: in the female ones, Germen ovate, naked; style simple; stigma

pointed, inflexed. *Peric.* none, except the scarcely altered calyx. Seeds in the disk none; in the radius obovate, naked. Recept. flat, woolly, and the elongated wool which separates the two rows of calyx-scales, is moreover introduced between the perfect and female florets.

Obf. A small compressed body adheres to the base of each scale of the calyx.

Eff. Ch. Receptacle woolly. Seed-down none. Calyx of ten equal leaves. Florets of the radius five, inversely heart-shaped.

The species are two, both shrubs natives of the Cape of Good Hope, and to be met with, though rarely, in our green-houses.

1. *E. africanus*. Linn. Sp. Pl. 1310. Ait. Hort. Kew. v. 3. 278. Curt. Mag. t. 833. (*E. sempervirens, foliis fasciculatis & digitatis*; Dill. Elth. v. 1. 132. t. 110. f. 134). "Leaves lobed or undivided. Flowers corymbose."—The leaves are fasciculated, fleshy, and nearly cylindrical, hoary and glaucous, mostly undivided, sometimes with two or three lobes or notches. Flowers resembling many species of Yarrow, *Achillea*, having broad white radiant florets, and a small purple and yellow disk. The seeds are enveloped in the long soft hairs of the receptacle which come forth after the flowering is past. It is propagated by cuttings, and flowers from January to March.

2. *E. racemosus*. Linn. Sp. Pl. 1311. Ait. Hort. Kew. v. 3. 279.—"Leaves linear, flat, undivided. Flowers racemose."—The leaves are shorter, flatter, and less fasciculated than in the former. Flowers in long clusters or rather spikes. Wool of the receptacle very long.—Dr. Sims in Curt. Mag. justly refers Gærtner's synonym to the foregoing species, not to this.

**ERIOGONUM**, from *εριον*, wool, and *γονν*, a joint, in allusion to the woolliness of the habit, and the jointed structure of the stem. Michaux Fl. Boreali-Amer. v. 1. 246. Class and order, *Enneandria Trigynia*. Nat. Ord. *Holoraceæ*, Linn. *Polygonæ*, Juss.

Gen. Ch. Cal. Perianth inferior, in six deep, obovate, coloured, spreading segments, of which the three innermost are somewhat the largest. Cor. none. Stam. Filaments nine, occasionally eight or ten, rather longer than the calyx and inserted into its base, hairy in their lower part; anthers roundish, versatile, incumbent. Pist. Germen superior, oblong, triangular, with three furrows; styles three, the length of the stamens; stigmas simple, obtuse. *Peric.* Capsule triangular, membranous, not bursting. Seed solitary, triangular, sharp at each end, black; with a snow-white, small, farinaceous albumen, and large flat cotyledons.

Eff. Ch. Calyx inferior, coloured, in six deep segments, permanent. Capsule membranous. Seed solitary, triangular. Stigmas simple.

This genus in its parts of fructification very nearly approaches *Polygonum*, but the above characters are sufficient to distinguish it, and the habit, more especially the absence of stipulas, renders it totally distinct. We are possessed of three species, one of which only has been hitherto mentioned.

1. *E. tomentosum*. Michaux as above, t. 24. (*Chrysofenium? oppositifolium*; Walter Fl. Carolin. 140.) Calyx woolly, stem-leaves whorled, sessile.—We have been acquainted with this plant ever since November, 1793, when a root brought by Mr. John Frazer from Carolina, flowered for the first time in his garden at Chelsea. It was drawn by Mr. Sowerby, but the figure remains unpublished. Michaux in the mean while has named and described this genus as above, giving an indifferent plate of the only species known to him, which, he says, grows in the driest fir woods of Carolina

Carolina and Georgia, and which is the very same as Mr. Frazer's, in whose herbarium we have seen a specimen from Mr. Walter, who named it, with a mark of doubt, *Chryso-splenium oppositifolium*, not being furnished with sufficient materials to judge how far he was correct or not. Michaux has given a specific character, a perilous attempt, and indeed an absurd one, for a solitary species, as it can only by accident serve to contrast that species with others as yet unknown. The *Root* is perennial, rather woody, stem a foot or more in height, erect, round, woolly, rusty-coloured, leafy, branched and forked, many-flowered. *Leaves* nearly entire, somewhat undulated; green, scattered with loose, deciduous, rusty down above; densely woolly and whitish, with rusty veins, beneath: the *radical* ones clustered, obovate, two inches in length, on broadish woolly footstalks about half as long, spreading: *stem-leaves* in numerous rather distant whorls, three or four in a whorl, sessile, scarcely an inch long, unequal, pointed: *Stipulas* none. *Braheas* either terminal or from the forks of the stem, solitary, sessile, cup-shaped, bluntly toothed, woolly, containing eight, ten, or more inodorous flowers on simple, slender, woolly stalks, each joined in the middle, and swelling upwards. Segments of the *calyx* elliptical, broad, obtuse, white at the edge, green clothed with rusty wool at the back. The base of the *stamens*, and summit of the *flower-stalks*, are tinged with purple. *Fruit* covered by the closed internal segments of the *calyx*, become contracted at their base, and a little undulated.

2. *E. parvifolium*. Calyx naked. Stem-leaves stalked, alternate, ovate, revolute.—Gathered in California by Mr. Archibald Menzies. The *stem* is shrubby, branched, leafy, with a deciduous, nearly smooth bark. *Leaves* alternate or clustered, about a quarter of an inch long, ovate, obtuse, revolute, almost if not quite entire; smooth and shining above; densely clothed with rusty wool beneath. *Footstalks* half as long as the leaves, very woolly, dilated at their base, but not quite embracing the stem. *Flowers* very numerous, in dense, globular, woolly tufts, one terminating each branch, and surmounted by another, on an elongation of the same branch, two inches above it. *Flower-stalks* smooth. *Calyx* smooth, or very slightly downy at the back, its segments oblong, obtuse, keeled, entire, not wavy. We have not seen the radical leaves, nor been able to investigate the *braheas*. The round tufts of very copious flowers, and the stalked scattered small leaves, at once distinguish this species.

3. *E. latifolium*. Calyx naked. Stem-leaves stalked, alternate, heart-shaped, undulated. Foot-stalks embracing the stem.—Gathered in California by Mr. Menzies, with the last. *Stem* shrubby. *Branches* round, woolly, leafy. *Leaves* alternate, two inches long, heart-shaped, bluntish, undulated and crisped at the edge; covered with a web of deciduous white down above; very woolly and white beneath. *Footstalks* as long as the leaves, woolly, sheathing the stem with their dilated bases. Some leaves are clustered about the end of each branch. *Flowers* not larger than in *E. parvifolium*, and, as in that species, very numerous in globose woolly tufts, terminating elongated, naked, woolly branches. Segments of the *calyx* obovate, keeled, somewhat undulated.

The addition of these two species confirms the very natural genus of *Eriogonum*, which in the Linnæan system should immediately follow *Rheum*. Probably more species are to be found in the unexplored wilds of North America. Those we have described would all certainly bear the climate of Britain, and though not splendid plants, are worthy of cul-

tivation for their singularity. Their qualities cannot be supposed different from *Polygonum* and *Atraphaxis*. S.

ERIPHORUM, from *εριον*, wool, and *φορον*, to bear, alluding to the woolly or cottony tufts borne by the plant when in seed. Cotton-grass.—Linn. Gen. 30. Schreb. 41. Willd Sp. Pl. v. 1. 312. Sm. Fl. Brit. 58. Juss. 27. Gærtn. t. 2. Class and order, *Triandria Monogynia*. Nat. Ord. *Calamaria*, Linn. *Cyperoides*, Juss.

Gen. Ch. *Spike*, or rather *Catkin*, imbricated every way: scales ovate-oblong, flat, slightly inflexed, pointed, membranous, loose, separating the flowers. *Cor.* none. *Stam.* Filaments three, capillary, anthers erect, oblong. *Pist.* Germen superior, very small; style thread-shaped, the length of the calyx-scale; stigmas three, longer than the style, reflexed. *Peric.* none. *Seed* triangular, pointed, surrounded at the base with numerous hairs longer than the spike.

Ess. Ch. Glumes chaffy, imbricated every way. Corolla none. Seed one, invested with very long hairs.

Six species are described by Willdenow, four of which are found in Britain, viz. *E. vaginatum*, Engl. Bot. t. 873; *polystachion*, t. 563; *angustifolium*, t. 564, long confounded with the last; and *alpinum*, t. 311. The exotic species are, *E. virginicum*, Linn. Sp. Pl. 77; and *cyperinum*, *ibid*; both natives of North America. The latter has browner and shorter hairs to the seed than any other, so as to have nothing of their striking appearance. The whole genus grows in a turfy soil, generally in wet places, to which the first species is an occasional exception, being sometimes found on dry mountainous heaths. Some German botanists have lately distinguished from the *vaginatum*, one which they name *E. Scheuchzeri*. This is *Eriophorum*, n. 1332 β. Hall. Hist. v. 2. 175. (*Juncus alpinus*, capitulo tomentoso majori; Scheuchz. Prod. 27. t. 7. f. 2.) It has creeping roots, solitary stems, not half so tall, but much stouter than those of *vaginatum*, with a much less remarkable sheath. The leaves also are very short; the hairs of the seed very dense and remarkably delicate. It grows in the most elevated marshy pastures of the Alps, or about the boggy borders of Alpine lakes, as mentioned by Scheuchzer, and is undoubtedly a distinct species.

ERIPHORUS, BULBUS, the Woolly Bulb, *εριφορος* *επιφορος*; of Theophrastus, book vii. chap. 13, who mentions it as "growing on the shore, and having between its outer coats and the inner part, which is eatable, a woolly substance, of which various garments are woven." Pliny observes, that Theophrastus does not inform us in what country this is practised. Dodonæus, among the moderns first instituted an inquiry into this bulb, Hist. Stirp. 692, giving a figure, communicated by a friend of whose fidelity he is very unwilling to doubt, of a plant hitherto unseen by any other mortal. It has scaly bulbs, more resembling tuberous roots invested with the permanent bases of the foliage; long sword-shaped leaves: and large solitary flowers, unlike every thing known in the vegetable world, being formed of five densely shaggy ovate spreading petals, and a sixth standing upright in the place of the stamens and pistils. This cut has always been judged fictitious, and, if true, it would not answer to the description of Theophrastus. Dodonæus, moreover, figures the *Scilla hyacinthoides* as one kind of *Bulbus eriophorus*, and refers to Clusius, who, in his Hist. Plant. 173, gives *Scilla peruviana* for another. Both these bulbs, and, indeed, some others, have, in fact, a woolliness about their upper part when the coats are torn asunder, apparently consisting of their large and tenacious spiral-coated sap-vessels; but the quantity or quality of this wool is not, in any instance that has come under our inspection, by any means adequate to the uses mentioned in Theophrastus.

**ERIOSPERMUM**, from *επισπ*, wool, and *σπέρμα*, seed. Jacq. Coll. v. 5. 72. Willd. Sp. Pl. v. 2. 110. Class and order, *Hexandria Monogynia*. Nat. Ord. *Coronarie*, Linn. *Asphodeli*, Juss.

Gen. Ch. *Cal.* none. *Cor.* bell-shaped, permanent, of six ovate, equal, keeled petals, three of which are exterior and most expanded. *Stam.* Filaments six, shorter than the corolla, awl-shaped, uniform, dilated at the base, smooth; anthers incumbent, oval, two-lobed. *Pist.* Germen superior, ovate, with six ribs; style erect, angular, as long as the stamens; stigma simple, obtuse. *Peric.* Capsule of three cells and three valves; partitions from the centre of each valve. *Seeds* several, affixed to the lower part of each partition, roundish, invetted with long prominent woolly hairs.

Ess. Ch. Corolla of six petals, bell-shaped, permanent. Filaments broad at the base. Capsule of three cells. Seeds invetted with wool.

This genus, than which none can be more natural, either with respect to character or habit, was established by Jacquin in the fifth or supplemental volume of his *Collectanea*, upon the *Ornithogalum capense* of Linnæus and Thunberg, with two other species. They all agree in their tuberous root; radical, stalked, solitary, elliptic-oblong, entire, involute leaves; and tall, naked, racemose, many-flowered stalks. The flowers are small; petals white with reddish, brown, or greenish keels.—They are all delineated in Jacquin's *Icones Plant. Rarior.* v. 2, as follows.

1. *E. latifolium*, t. 420. (*Ornithogalum capense*; Linn. Sp. Pl. 441. Commel. Hort. v. 2. t. 88.) Leaves broadly elliptical, somewhat heart-shaped, recurved.—The leaves are of a dark shining green. *Partial flower-stalks* two inches long. *Petals* with a rose-coloured rib.

2. *E. lancifolium*, t. 421. Leaves ovate-lanceolate, acute, erect.—The upper side of the leaves is represented glaucous by Jacquin, their backs of a grass green. *Partial flower-stalks* but an inch long. *Petals* with a brownish rib.

3. *E. parvifolium*, t. 422. Leaves elliptical, obtuse, erect, flat. The leaves of this are glaucous, reticulated, and much smaller than in either of the former, being but from an inch and half to two inches long. *Petals* with a green rib. *Partial-stalks* an inch long, spreading.

All these species are natives of the Cape of Good Hope. We suspect that Bengal and the coast of Guinea may afford one or two more, but we are not furnished with materials sufficient to ascertain them completely.

**ERIOSTEMON**, from *επισπ*, wool, and *στέμον*, a stamen, alluding to the fringed filaments. Sm. *Transf. of Linn. Soc.* v. 4. 221. Class and order, *Decandria Monogynia*. Nat. Ord. *Rutaceæ*, Juss.

Gen. Ch. *Cal.* Perianth inferior, in five deep segments, nearly equal, permanent. *Cor.* Petals five, ovate, sessile, regular and equal, somewhat spreading, mostly five times as long as the calyx, sometimes rough, inserted under a glandular nectary, which surrounds the base of the germen. *Stam.* Filaments 10, awl-shaped, flattened, clothed or fringed with fine spreading hairs; anthers on terminal stalks, roundish with a small point, two-lobed, incumbent, smooth. *Pist.* Germen of five lobes, superior, standing on the nectary, each lobe somewhat ovate, triangular, acute, soon spreading; style central, from the base of the germen, erect, cylindrical, elongated after flowering, smooth; stigma capitate, with five notches. *Peric.* Capsules five, connected by their base, ovate, compressed, coriaceous, of two valves, enclosing an elastic, cartilaginous, bivalve arillus. *Seeds* solitary, kidney-shaped, brown, smooth.

Ess. Ch. Calyx in five deep segments. Petals five, sessile.

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Stamens flat, fringed. Anthers stalked, terminal. Style from the base of the germen. Capsules five, combined, seated on a glandular nectary. Seeds enclosed in an arillus.

Obs. Some species have a four-cleft flower, with but eight stamens, and others have five of their 10 stamens imperfect and abortive.—This genus differs from *Boronia*, Sm. *Tracts on Nat. Hist.* 287. t. 4—7, in having the anthers upon terminal footstalks, and the style from the base of the germen; not to mention the flowers being generally five-cleft and decandrous, and the leaves usually alternate. From *Correa* and *Crovea*, see vol. 10, its differences are evident from the characters there given of those genera. We are happy here to mention that the long-desired *Correa rubra* flowered, for the first time in Europe, at Messrs. Lee and Kennedy's, Hammermith, in June 1809.

The species of *Eriostemon* in our possession are six.

1. *E. salicifolia*. Willow-leaved Eriostemon.—Leaves linear-lanceolate, flat, straight, naked on both sides. Branches smooth. Flowers lateral. Gathered near Port Jackson, New South Wales, by John White, M.D. who communicated dried specimens to us in 1791, but it has not yet appeared in the gardens. This is a very handsome flowering shrub, with numerous, alternate, wand-like, leafy, smooth, angular branches, having indeed much of the habit of *Crovea saligna*. *Leaves* alternate, from one to two inches long, but little spreading, linear-lanceolate, entire, bluntish with a small point, thick and coriaceous, naked and smooth on both sides, besprinkled with glandular dots, scarcely veiny, but marked with an obsolete central rib; their base tapering down into a short flat footstalk. *Stipulas* none. *Flowers* pink, resembling those of *Crovea saligna*, on short, simple, solitary, axillary, angular, downy, bracteated stalks. *Bractees* imbricated, roundish, obtuse, concave, pale, downy, fringed. Segments of the calyx much resembling the bractees, about a line long, imbricated at their base. *Petals* alternate with them, and five or six times as long, obovate, spreading, bluntish, clothed with short, dense, scurvy pubescence, especially on the outside. *Filaments* about one-third as long as the corolla, red, all clothed from the base with dense, white, spreading hairs, and terminated by a naked, club-shaped, obtuse, red stalk, which in the five innermost alternate ones is much longer, thicker, and more glandular, than in the rest, rendering those stamens conspicuously the longest; anthers at the top of each stalk, incumbent, uniform, all fertile, ovate, of two cells, bursting longitudinally on their inner side, tipped with a small, pale, reflexed scale or crest. *Style* shorter than the stamens.

2. *E. luxifolia*. Box-leaved Eriostemon.—Leaves elliptical, keeled, revolute, with a recurved point. Branches hairy, round. Flowers lateral.—Gathered near Port Jackson, by Dr. White. Of this we have two very distinct varieties, for considering the Proteus-like nature of the leaves in New Holland plants, in which alone these differ, we dare not call them distinct species. In one the leaves are obovate, narrow at the base, bluntly crenate and glandular at the edges; in the other they are broadly elliptical, heart-shaped, and embracing the stem at their base, generally even and entire at their edges, though occasionally furnished, in the very same manner, with blunt glandular teeth. In both the branches are round, clothed with short prominent hairs. *Leaves* numerous, scattered, scarcely half an inch long, coriaceous, nearly smooth, keeled, with a sharp recurved point, and a thick, slightly revolute, margin. *Flowers* towards the ends of the branches, axillary, solitary. *Stalks* rather shorter than the leaves, thickened upwards, slightly

## ERIOSTEMON.

slightly hairy, with several minute, crowded, roundish, smooth *bracteas* a little above their base. *Calyx* much resembling the *bracteas*. *Petals* whitish or rose-coloured, almost as large as in the former, but smooth or very slightly downy; more spreading and recurved. *Filaments* minutely fringed, their terminal stalks awl-shaped, bearing a few long scattered hairs; anthers much like the former but shorter, and with a shorter broader point. *Germen* smooth, with very pointed lobes; style shorter than the stamens.

3. *E. falsifolia*. Salt-wort-leaved Eriostemon.—Leaves crowded, linear, obtuse; flattened above; convex beneath; rough-edged, straight. Flowers terminal.—Gathered by Dr. White near Port Jackson, with the last. It seems a more humble shrub than either of the foregoing, and has angular *branches*, all over scarred where former leaves have stood; slightly hairy when very young. *Leaves* very numerous, somewhat imbricated, half an inch or less in length, fleshy, linear inclining to obovate, obtuse, flattish above, convex beneath, more or less rough-edged, and sometimes otherwise pubescent, dotted with scattered glandular points, which in the dried leaves are prominent tubercles. The base tapers down into a very short broad *footstalk*, articulated with a decurrent prominence of the branch. *Flowers* few, terminal at the top of each branch, on short, simple, smooth stalks, which are minutely bracteated at their base. Segments of the *calyx* short, broad and acute. *Petals* recurved, downy, pale red with a darker keel. *Filaments* smooth at the base, their upper part, and terminal stalks, densely clothed with long, upright, white hairs, almost concealing the anthers, which are oblong, with a very minute point or crest. *Germen* smooth, with obtuse lobes.—The stamens in these three species would afford beautiful specific differences, were not those of the leaves more commodious and obvious.

4. *E. uniflora*. Single-flowered Eriostemon.—Leaves scattered, elliptic-lanceolate, smooth; paler beneath. Flowers solitary, terminal, on short stalks. Five of the stamens abortive. (*Diosma uniflora*; Linn. Sp. Pl. 287. Ait. Hort. Kew. v. 1. 276. Mart. Mill. Dict. v. 2. n. 17. Curt. Mag. t. 273. Schrad. Sert. Hannov. 16. t. 8.)—Native of the Cape of Good Hope, from whence it was sent to the Kew garden, in 1775, by Mr. F. Masson, and is now not unfrequent in collections, being much esteemed for its beautiful flowers, produced abundantly in the spring and early part of summer. This is a shrub from one to two feet high, much branched, strongly, but not agreeably, aromatic in all its parts. *Branches* leafy, nearly smooth. *Leaves* scattered, on short, rather hairy, *footstalks*, elliptic-oblong, often nearly linear, obtuse, very glandular, paler beneath, very obscurely crenate, and somewhat fringed, varying in length from half an inch to an inch. *Flowers* solitary at the end of each branch, but from the number of the short branches they sometimes appear cymose. *Stalks* much shorter than the leaves, swelling upwards, downy, without *bracteas*. Segments of the *calyx* near half an inch long, lanceolate, purplish, fringed. *Petals* twice as long as the *calyx*, obovate, pointed, of a shining varnished white, like porcelain, or often bluish-coloured above; purplish beneath. *Stamens* about the length of the *calyx*, their filaments all fringed; five of them short, bearing large heart-shaped anthers, with greenish glandular tips; five much longer and more slender, each terminating in a small round stalked gland, without any anther, varying in size and shape. *Germen* globular, clothed with numerous stalked nectariferous glands; style and stigma like the other species. Curtis and Schrader have well described this plant, but neither of them was sufficiently acquainted with the real species of *Diosma*, now nu-

merous in our gardens, to discover that it was generically distinct, and that the curious nectary, essential to *Diosma*, was wanting. Schrader endeavours to make his description of that part agree with the generic character, but in vain, and his accuracy would soon have discovered the truth, had he seen a real *Diosma*. The *Hankaea* of Schmidt in Uster's Annals, fasc. 6. 117, to which Schrader refers, agrees in generic characters with *Diosma barbiger* of Linnæus, and not with our *Eriostemon*.

5. *E. marginata*. Bordered Eriostemon.—Leaves scattered, lanceolate, paler beneath. Flower-stalks axillary, twice as long as the leaves, corymbose. Five of the stamens abortive. (*Diosma marginata*; Linn. Suppl. 155.) Native of the Cape of Good Hope, raised by Messrs. Lee and Kennedy, with whom it flowered in June 1809. It agrees very much in habit with the last, but has a more pleasant smell, like sassafras or myrrh, when rubbed, and differs very essentially in the great length of its *flower-stalks*, which are not terminal, but spring from the bosom of several of the uppermost leaves, and rising above the summit of the branch, make a sort of corymbus. A pair of lanceolate *bracteas* grow either near the top of each stalk, or towards its middle, or in our garden specimens, near the base. Their precise situation seems not characteristic of any specific difference. The segments of the *calyx* vary in breadth, and are often fringed, sometimes smooth. *Petals* mostly notched at the extremity, but otherwise like those of *E. uniflora*, as are also the *stamens*. The *leaves* vary greatly in length and breadth. Their membranous margin, whence the name is taken, is often very conspicuous in the dried plant, but we cannot perceive it in the living one, nor even in our garden specimens when dried, still we would not presume to change a name founded in truth, though not always applicable; otherwise *pedunculata* would be a more eligible one. Our remarks on this species are made from various specimens named and unnamed in the Linnæan herbarium, which vary greatly in the hairiness or smoothness of their branches and leaves, as well as the form and breadth of the *calyx*, but we can find no positive specific distinction among them. The leaves in some are nearly opposite, but never constantly so. We know, from frequent observation, that the last species is extremely variable, and are persuaded that this is subject to equal differences. The inflorescence, however, of each is so constant, that they can never be confounded together.

6. *E. paradoxa*. Various-leaved Eriostemon.—Leaves lanceolate, revolute, downy beneath; simple, ternate, or pinnate. Flowers lateral, four-cleft. Stamens eight. Sent from Port Jackson, New South Wales, by Dr. White.—*Stem* shrubby, with numerous, opposite, round, rough, leafy *branches*. *Leaves* an inch, more or less, in length, lanceolate, obtuse, entire, somewhat revolute; smooth and naked above; clothed with dense, white, entangled or starry pubescence beneath. In one variety they are simple, almost perfectly opposite, on short *footstalks*; in another smaller, ternate, sessile on one common winged stalk, which is about half the length of the lateral pair; in a third they are as large as in the first, and are either ternate or consist of two pair and an odd one, all sessile on a similar, but longer, winged stalk. The pinnate and the ternate kinds are unquestionably but varieties of each other, nor can we think the first a distinct species, however paradoxical our opinion may seem. The *flowers* of all are exactly alike. *Flower-stalks* copious, axillary, solitary, shorter than the leaves, simple, single-flowered, angular, clothed with rusty starry scales or pubescence. *Bracteas* two, towards the middle of each stalk, obovate, rusty, small. *Calyx* downy and rusty, quadrangular

quadrangular at the base, its four segments ovate, broad, keeled. *Petals* four, thrice as long as the calyx, elliptical, keeled, rose-coloured, smoothish above, downy beneath. *Filaments* eight, all nearly equal, rather shorter than the calyx, red, thick, obtuse, glandular, fringed in their lower part; anthers short and roundish, each on a short, slender, white, terminal stalk, their white tip or crest very minute. *Germen* reddish, with four blunt lobes.—We have hesitated whether to refer this plant to *Boronia*, with which genus it agrees best in habit, and number of parts in the fructification, but the insertion of the anthers and of the style have always appeared to us rather like *Eriostemon*. We have never seen it alive. Future observations on the living plant may correct our present determination. It appears to be one of the prettiest shrubs that New South Wales affords, and would be a welcome acquisition for the English conservatories. S.

ERIOX, or ΕΡΙΟΞ, in *Ichthyology*, a species of Salmo, called by Pennant, Willughby, and Ray the *Grey*. See SALMO.

ERISANA, in *Ancient Geography*, a town of Spain, in Lusitania.

ERISKAY, in *Geography*, one of the western islands of Scotland, separated from South Vist by a narrow strait, called "Eriskey Sound;" about five miles in circumference.

ERISMA, in *Botany*, according to the author of the name, is derived from *επιιδω*, to prop, or support, and not from *ερισ*, to dispute, or contend. Rudge Pl. Guian. 7. Class and order, *Monandria Monogynia*. Nat. Ord. uncertain.

Gen. Ch. *Cal.* Perianth of one leaf, permanent, downy on both sides, in four deep unequal segments, one of which is much the longest, irregular, obtuse, behind the larger petal; the rest sharper, and half-lanceolate. *Cor.* Petals two, opposite, unequal, emarginate, the uppermost united with the calyx betwixt its lesser segments, broad, roundish; its base ending in a horn-like, blunt *nectary*, the length of the petal, downy externally, like the calyx; the lowermost thrice as long as the other, and broader, inserted into the receptacle behind the perfect filament. *Stam.* Filaments five; one of them fertile, as long as the upper petal, incurved, inserted into the receptacle; the other four very short, abortive; anther arrow-shaped, narrow. *Pist.* *Germen* inferior, oblong, of one cell; style thread-shaped, as long as the filament, ascending; stigma blunt. *Peric.* unknown. Rudiments of seeds two, oblong.

Ess. Ch. Calyx in four deep unequal segments. Petals two, unequal; the uppermost united with the calyx, spurred at its base; the lowermost inserted into the receptacle. Fruit with two seeds.

*E. floribunda*. Rudge t. 1. Native of Guiana. A tree or shrub with round branches, when young clothed with starry down of a brown colour. *Leaves* large, nearly opposite, elliptical or obovate, obtusely pointed, entire, smooth, with numerous parallel veins. *Stipular* small, deciduous. *Panicles* large, terminal. *Bractees* in pairs, very unequal, downy, the smallest about a line long, the other four lines long, broad and ovate. The flowers are very small, and concealed by the bractees. Of their colour or properties we have no account.

ERISMATOLITHUS, in *Natural History*, and *Mineralogy*, is the name of a genus in the animal order of remains (*reliquia*, or relics) of a former race of beings, which inhabited the earth or its waters, and includes the *fulciments* or plant-like supports which certain animals fabricated for their support and habitation, and which are preserved in a fossil state. According to Mr. William Martin (*Outlines of the Knowledge of extraneous Fossils*, p. 193.) the essential characters or diagnostics of the permanent species in this

genus are to be sought in various parts of the *reliquium*, e. g. "In reliquia of cellular fulciments, the stirp exhibiting the internal form or structure of the cells: in reliquia of solid fulciments, the stirp exhibiting its external form." The temporary species of this genus are to comprise such cellular fulciments as do not shew the structure of their cells, and such solid imperfect specimens as are not reducible to known species. The fossil corals, corallines, sponges, &c. rank under this genus. See RELIQUIA.

ERISTALIS, the name of a stone, mentioned by Pliny and the ancients, and of which a very memorable quality is recorded by them, which is, that though it was naturally white, it would occasionally turn red.

ERISTICI, from *ερις*, dispute, in *Botany*, such authors as have attempted the study of that science in a philosophical way, and have been publicly engaged in disputes about the true foundation of its several distinctions, &c.

ERITHACE, a name given by the ancients to the yellow matter collected on the hinder legs of the bees after their excursions in search of the materials for their hives; we usually esteem this to be real wax, and the French call it *cire*, brute, or rough-wax; it is certain, however, that though the matter of which wax is to be formed is contained in this substance, yet the Dutch and some other nations have the most just idea of it, in calling it *pain des abeilles*, or the food of the bees.

This substance is only the farina of flowers, and no experiment has been able to separate real wax from it. The most probable opinion concerning it is, that it serves the bees as food, and that after this it is converted in their bowels into the substance called wax.

ERITHALIS, in *Botany*, Εριθαλις; is an ancient name of some plant now unknown, derived from *εριθαλις*, highly verdant, or beautifully leafy. Browne adopted it for the present genus, and was followed by Jacquin and Linnæus.—Browne Jam. 165. Jacq. Amer. 72. Linn. Gen. 95. Schreb. 130. Willd. Sp. Pl. v. 1. 996. Mart. Mill. Dict. v. 2. Juss. 206. Gærtn. t. 26. Class and order, *Pentandria Monogynia*. Nat. Ord. *Rubiacea*, Juss.

Gen. Ch. *Cal.* Perianth superior, of one leaf, cup-shaped, with five teeth, permanent. *Cor.* of one petal, deeply five-cleft; tube very short; segments of the limb long, lanceolate, recurved. *Stam.* Filaments five, awl-shaped, spreading, scarcely so long as the corolla; anthers oblong. *Pist.* *Germen* inferior, roundish; style thread-shaped, compressed in the upper part, the length of the stamens; stigma acute. *Peric.* Berry globose, crowned with the base of the calyx, of ten cells, (sometimes but eight, *Gartner*.) Seeds small, solitary, pendulous.

Ess. Ch. Corolla in five deep recurved segments. Calyx cup-shaped. Berry inferior, of ten cells. Seeds solitary.

The species are, -

1. *E. fruticosa*. Linn. Sp. Pl. 251. (*E. odorifera*; Jacq. Amer. 72. t. 173. f. 23. *E. fruticulosa*; Brown. Jam. 165. t. 17. f. 3. *Sambucus ligno duro odoratissimo*; Plum. Ic. 247. t. 249. f. 2.)—Leaves obtuse. Flower-stalks all cymose, many-flowered.—Native of Jamaica, and other West Indian islands, growing near the sea-side, and very various in height and luxuriance, according to its situation. Stem shrubby, with round, smooth branches, leafy towards their extremities. *Leaves* opposite, stalked, obovate, entire, about two inches long, various in breadth, obtuse, smooth and shining. *Flowers* white, smelling (according to Jacquin) like the common lilac, growing many together, in long-stalked, axillary, cymose panicles, about the ends of the branches, but they are not terminal as Willdenow describes them. *Berries* purple, the size of a pea.—Jacquin

describes another species or variety, he is doubtful which, with inodorous flowers, whiter berries, and a more humble diffuse stem, growing on barren maritime rocks in the island of Curaçao. This we have never seen.

2. *E. polygama*. Forst. Prod. 17.—Leaves acute. Male flowers cymose; perfect ones solitary.—Gathered by Forster in the Society Islands.—That writer refers to the *Timonius*, Rumph. Amb. v. 3. 216. t. 140, as a narrower-leaved variety of his plant. This is, indeed, to all appearance, an *Erihalis*. Rumphius informs us that it grows in grassy open hilly places in Amboyna, and the neighbouring islands.

The stem is the height of a man. Leaves four or five inches long, and as broad as two fingers, acute at each end. Flowers of a dirty white. Berries yellowish-black, eaten by starlings and other birds. The roots are used by the natives to chew, along with a slight mixture of cloves, nutmegs and ginger, in their maritime excursions, in which they suffer much from cold and other inconveniences.

ERITRI, in *Geography*, a town of Asiatic Turkey, in the province of Natolia; 36 miles W. of Smyrna.

ERITZKA, a town of Russia, in the government of Irkutsk; 20 miles E. of Kirensk.

ERIVAN, called *Persian Armenia*, *Greater Armenia*, and *Eastern Armenia*, a province of Persia, about 200 leagues in length, and 60 in breadth. See ARMENIA.

ERIVAN, *Iravan*, or *Iriwan*, a city of Asia, and capital of Greater Armenia, or Erivan; situated in a plain, surrounded with mountains, and watered by two small rivers; large, dirty, and ill built, and but indifferently peopled: the ramparts are of earth; the fortress is encompassed with a wall of bricks, in which are a palace for the governor, and 800 houses, inhabited only by Persians; the Armenians have shops there, but must not remain during the night. The churches are small, and half buried in the ground, resembling catacombs; in the town and its environs they reckon 28 convents for devotees of both sexes, but they are poorly endowed.

ERIX, or ERYX, in *Ancient Geography*, a mountain of Sicily, situated towards the western part, near the sea. Solinus says, that it was consecrated to Venus. Polybius places it between Drepana and Palermo. According to Apollodorus, this mountain derived its name from a son of Venus, called *Erix*. It is now called "Monte St. Giuliano," or "Monte di Trapani."—Also, a town of Sicily, now "Trapani del Monte," situated on the summit of mount Eryx, difficult of access, and famous for a temple of Venus, called Erycina. Polybius and Strabo mention this town. Minos decorated this temple with superb sculpture, and enriched it with such noble offerings, as have claimed for him the honour of being its founder. The victims offered themselves voluntarily at the altar. The most beautiful women in the world were the priestesses, and the Roman senators, laying aside their characteristic severity, came hither to indulge in pleasure with the beautiful Sicilian females, persuaded they should thus make their offerings acceptable to the goddess, and render her propitious. In the time of Strabo the town and temple were much decayed. It is said that Eryx was destroyed by Hamilcar, who in the first Punic war, A. U. C. 493, removed its inhabitants to Drepanum, which he had built not long before. Nothing now remains but a paltry village, and some foundations of a temple.

ERIZZO, SEBASTIAN, in *Biography*, a noble Venetian, was particularly distinguished for his knowledge of the medallic science. He published, in 1559, in Italian, "A

Discourse upon Ancient Medals," which has been highly esteemed for its erudition. He contended for the difference between the medals and coins of the ancients. Erizzo was the author of a treatise on "Logic;" a translation of "Plato's Dialogues;" a discourse on "Civil Governments," and some other pieces. He died in 1585. Gen. Biog.

ERKELENS, or EREKELENS, probably *Herculanum*, in *Geography*, in the days of the Romans, is an ancient town of France, in the department of the Roer, chief place of a canton, in the district of Crévelt, with a population of 1340 individuals. It is at a distance of about three miles from the river Roer, 15 miles north of Juliers; its ancient fortifications were demolished by the French in 1674. The canton contains 48 communes, and 17,853 inhabitants.

ERLA, a small town of the kingdom of Saxony, in the circle of the Ertzgebirge, at the foot of the mountain called Rothenberg, remarkable for a rich mine of excellent iron, the best of the whole of this mountainous district. Its iron works are celebrated for casting the best ovens and frying-pans in Saxony; there is also a manufactory of cannon-balls. There was anciently a small town of the same name in Russia, in the government of Riga, not far from Dorpat; but it is now in ruins.

ERLACH, in French *Cerlier*, a small town of Switzerland, in the canton of Berne, at a distance of about three quarters of an English mile from the upper part of the beautiful lake of Biemme, is situated on the declivity of the Julimont, or Julius' mountain, for it is proved beyond contradiction that Julius Cæsar established upon this hill one of his strong entrenched camps. This elevation is also called Jolimont, pretty mount, from the beauty of the prospect, which can be no where more varied, or more interesting, on account of the number of picturesque contrasts which it affords. Travellers who wish to visit the famous island of St. Pierre, in the lake of Biemme, generally take a boat at Erlach. It has an ancient castle, which gave the title of barons to the illustrious Swiss family of the Erlachs, who, from the time of the intrepid Ulrich of Erlach, have held such a distinguished place in the annals of their country.

ERLANG, or ERLANGEN, a handsome town of Germany, in the circle of Franconia, in that part of the margraviate of Anspach Baireuth which was called the principality of Culmbach, on the river Rednitz, 18 miles N.W. of Nuremberg, and 30 miles S. of Bamberg. N. lat. 49° 38'. Until the peace of Tilsit, concluded in July 1807, between France and Prussia, this town, and the whole margraviate of Anspach Baireuth, belonged to the kings of Prussia, to whom it had been ceded by the last margrave, in 1792: but it is now at the disposal of the French emperor.

Erlang is divided into the old and new town; the latter is also called Christian Erlang, from the name of its founder, the margrave Christian Ernest, who built it in the year 1686 to accommodate several families of Protestant French refugees. The streets of both towns are regular and spacious: there are two handsome squares, and some fine churches. The principal manufactures established by the French refugees were those of hosiery and of hats, which are still flourishing. In 1742 the university of Baireuth was also removed to Erlang.

ERLAU, in Latin *Eger*, or *Agria*, a town of Upper Hungary, in the district of Heves, near which there is a fine hot mineral spring, which is used for bathing. It is the see of a bishop, and the seat of an university, the buildings of which are very fine: the professors are well accommodated, the lecturing rooms very good, and the chapel, library, and public hall extremely elegant. The see of Erlau is one of the

the richest in the kingdom. The town is in general ill built, the only good houses are those of the canons of the cathedral. There is, however, a Turkish tower in good condition. The only remarkable manufactures are those of wax and of leather. The neighbourhood of Erlau is famous for an excellent sort of Hungary wine, little inferior to the best Burgundy.

ERLEBACH, a river of Germany, which rises in the duchy of Stiria; 6 miles below Ips.

ERLEBACH, a town of Germany, in the circle of the Lower Rhine, and electorate of Mentz, on the Main; 3 miles N.N.W. of Clingenberg.

ERLENBACH, a town of Germany, in the circle of Franconia, and county of Wertheim; 10 miles N.N.E. of Wertheim.

ERMELAND, or ERMLAND, in Latin *Varmia*, one of the four subdivisions of that part of the kingdom of Prussia which is called Eastern Prussia. In ancient times, two-thirds of this country belonged to the bishops of Ermeland, who were princes of the German empire, and one-third to the chapter of the cathedral church of Frauenburg. The bishop enjoys still a very considerable income.

Ermeland is particularly remarkable for its hemp and flax, and its linen yarn, great quantities of which three articles are annually exported to England in time of peace. The principal towns are Frauenburg, the see of the bishop; Braunsberg, the chief city, which alone exports yarn to nearly the annual amount of two millions of guilders; Heilsberg, Allenstein, Rößel, Wormdit, &c.

ERMENEK, a town of Asiatic Turkey, in the province of Caramania; 63 miles S. of Cogni.

ERMENONVILLE, a small town of France, in the department of the Oise, chiefly remarkable for its beautiful park, and a castle, which derives some celebrity from having belonged to the handsome Gabrielle, mistress of king Henry IV. of France. But Ermenonville is become far more famous in modern times, for having been the last retreat of the eloquent and misanthropic Jean Jaques Rousseau, who died here on the 2d of July 1778, and to whom a handsome monument has been erected in a small island called the island of poplars, which is in the middle of a fine lake. This monument is remarkable for the beautiful simplicity of its inscription.

“ Ici repose l'homme de la nature et de la vérité.”

“ Here reposes the man of nature and of truth.”

ERMESIA, a name given to a composition used among the ancients, and famous for its effects in making people beget handsome children. It consisted of honey, myrrh, saffron, and palm-wine, all beaten together. This mass was to be taken mixed in milk. The women took it as well as the men, and many had great faith as to its effects.

ERMIJA, in *Geography*, a town of Spain, in the province of Biscay; 16 miles E.S.E. of Bilbao.

EKMIL, a town of Russia, in the government of Tambou; 44 miles S. of Tambou.

ERMIN, or ERMINE, in *Heraldry*, denotes a white field or fur, powdered or interspersed with black spots, called powdering. See *FUR*.

It is supposed to represent the skin of an animal of the same denomination. In effect, there is no animal whose skin naturally corresponds to the herald's ermin.

The animal is milk white; and so far is it from having spots, that tradition reports, that it will rather die, or be taken, than fully its whiteness. Whence its symbolical use.

But white skins having for many ages been used for the

linings of the robes of magistrates and great men; the furrriers at length, to add to their beauty, used to sew bits of the black tails of those creatures upon the white skins to render them the more conspicuous. Which alteration was introduced into armoury.

The fable spots in ermin are not of any determinate number, but they may be a greater or less, at the pleasure of the painter or furrrier.

ERMIN, an order of knights, instituted in 1450 by Francis I. duke of Bretagne, and formerly subsisting in France. The collar of this order was of gold, composed of ears of corn in saltier; at the end of which hung the ermin, with this inscription, *a ma vie*. But the order expired when the dukedom of Bretagne was annexed to the crown of France.

ERMINE', a cross erminé is a cross composed of four ermine spots.

It must be observed, that the colours in such arms are not to be expressed, because neither the cross nor the arms can be of any colour but a white and black.

Colombiere blazons it quatre queues d'ermine en croix. The editor of Guillim describes it thus; a cross of four ermines; or, more properly, four ermine spots in cross. It is the coat of Hurston in Cheshire.

ERMINE, *timbre of*. See *TIMBRE*.

ERMINE, in *Zoology*. See *MUSTELA Erminea*.

ERMINES is used by some English writers for the reverse of ermine, *i. e.* for white spots on a black field; but on what foundation nobody can tell; for the French, from whom we have our heraldry, have no such term; but call this black powdered with white contre-ermine; as denoting the counter, or reverse of ermine, which is white powdered with black.

ERMINEUM ANIMAL, *float*, or *ermine*, the creature whose skin is the ermine, so much esteemed as a fine fur.

This creature is properly a species of weasel, and is called by Mr. Ray, and other authors, *mustela candida*, the white weasel, and by Linnæus *mustela erminea*. It is in all respects like the common weasel, and is all over of a pure snow white, except the tip of the tail, which is of a beautiful black, and it has a little yellowish grey about the eyes, and a mark or spot of the same colour on the head, another on the shoulders, and a third near the tail. Its colour is, however, very different in degree and elegance, according to the season of the year. It is frequent about rivers, and in meadows, in those countries which produce it, and feeds on moles, mice, and other small animals. The skins and tails are a very valuable article of commerce in Norway, Lapland, and Russia, and other cold countries, where they are found in prodigious numbers, and regularly change their colour in winter, becoming white. In Siberia, they burrow in the fields, and are taken in traps, baited with flesh. In Norway they are shot with blunt arrows, or taken in traps. The float is sometimes found white in Great Britain, and called the white weasel. See *MUSTELA*.

ERMINITES should seem a diminutive of ermines, and naturally to signify little ermines; but it is otherwise. Erminites expresses a white field powdered with black; only that every spot has a little red hair therein.

Some authors use the word erminites for a yellow field powdered with black, which the French express much better by, or, *semée d'ermine de sable*.

ERMINOIS expresses an or field, with fable powdering.

ERMS, in *Geography*, a river of Germany, which runs into the Danube, four miles S.W. of Nurlingen, in the circle of Swabia.

ERMSLEBEN, a town of Germany, in the circle of Lower

Lower Saxony; and principality of Halberstadt; 14 miles S. E. of Halberstadt.

ERNANI, a town of Spain, in the province of Guipulcoa; 5 miles S. of Sebastian.

ERNATIA, a town of Asiatic Turkey, in the province of Natolia; 16 miles N. W. of Satalia.

ERNE, the name of a river in Ireland, which rises near the boundaries of the counties of Longford and Cavan, and passes through loughs Gawnah and Oughter in the latter county. From the last of these lakes it continues a northern direction till it flows into lough Erne, a little below Belturbet. The superfluous waters of this lake are discharged by a rapid current of about seven miles, which is also called Erne, and which falls into the bay of Donegal, below Ballyshannon.

ERNE-Lough, a lake of the county of Fermanagh, Ireland, which is supposed to occupy above 45,000 acres. It consists properly of two lakes connected by a broad winding channel of about six miles. The upper lake is nine miles long, and from one and a half to five wide; the lower lake extends in length about ten miles, and in breadth from two to eight. Both these lakes are full of islands, being said to contain from three to four hundred, the number varying according to the season, being more numerous in winter than in summer, on account of the greater height of the water. Some of these islands are large and inhabited, and many of them well wooded, so that the variety of interesting prospects afforded by them and the neighbouring coast is astonishing, and far surpasses the power of description. A canal to open the navigation from the lough to the sea has been projected, and would be attended with great advantage to the whole of Fermanagh and Cavan. It is also probable that a considerable part of the lake might be drained, and notwithstanding its beauty, it is a pity that so many acres should be unprofitable.

ERNE'E, a small town of France, in the department of Mayenne, chief place of a canton, in the district of Mayenne, with a population of 4740 individuals. It is situated on the river Ernée, 15 miles W. of Mayenne. The canton contains 6 communes and 15,053 inhabitants, on a territorial extent of 232 kilometres and a half.

ERNES, in our *Old Writers*, signify the loose scattered ears of corn that are left on the ground, after the binding or cocking of it.

It is derived from the old Teutonic *ernde*, harvest; *ernden*, to cut or mow corn. Hence *ern* is, in some places, to glean.

ERNEST, in *Biography*. See MANSFELD.

ERNEST Town, in *Geography*, a township of Upper Canada, in the midland district, the finest above Kingston, sheltered from lake Ontario by Amherst island, which lies in its front.

ERNESTI, JOHN AUGUSTUS, in *Biography*, was born in August, 1707, at Tennstadt, where his father was superintendant. He studied at Pforta, and soon displayed uncommon talents; he afterwards applied himself to the study of theology at Leipzig, and took his degree of M. A. in the year 1730. In 1734, having been elected rector of Thomas's school in the room of Gesner, ancient literature, and those branches of knowledge connected with it, became the principal objects of his pursuit. The successful application of his talents in this department of knowledge caused him to be chosen, in 1742, extraordinary professor of ancient literature, in 1756 he was elected public professor of eloquence, and in 1758, he was made doctor and professor of theology. He died in the year 1781, having, till within the last two or three years, been incessantly engaged

in the laborious discharge of his public duties. For twenty years and more he passed the greater part of each day in instructing others, yet he found ample time for the publication of many original works, and for editing various ancient authors. Among the latter may be mentioned, 1st, the *Memorabilia of Xenophon*, which has been frequently republished in this and other countries. 2d, *Cicero's Opera omnia cum clave*, in 6 vols. The *Clavis* has been published separately. Ernesti, in preparing this work for the press, employed the best and oldest editions of Cicero, as well as several MSS.; he examined critically the text of Gruter, corrected in it a great many faults, and in his short notes, he has in various places illustrated, and in others restored the original. He also gave the world new editions with notes of Suetonius, Tacitus, Homer, &c. He published *Aristophanis Nubes*, cum *scholiis antiquis et Prefat*; *Hederici Lexicon*, multis *vocabulorum millibus auctum*; a *New Theological Library*, in 11 volumes; and "*Institutio interpretis Novi Testamenti*," which has passed through several editions. Alberti of Leyden was so much delighted with this, that he called it "*The Golden Work*." A new edition of it was published in Holland within a few months after it was printed at Leipzig. The extensive talents and sober judgment of Ernesti enabled him not only to embrace every department of literature, but to examine and illustrate many of its obscurities and difficulties. He possessed a ready and retentive memory, and, above all, an honest and upright heart. "*Though*," says his biographer, "*the seriousness of his countenance bespoke a character hostile to every kind of levity, and born for labours that require great vigour and exertion, he was a friend to cheerfulness, and his company, on account of his easy behaviour and good humour, which was often heightened by Ciceronian wit, but confined within the boundaries of virtue and decency, made his conversation much sought after, and highly agreeable.*" *Gen. Biog.*

ERNODEA, in *Botany*, from *ἐρνώδης*, branched, so that it ought rather to be written *Hernodea*. Swartz. *Prod.* 29. *Fl. Ind. Occ.* v. 1. 223. Schreb. 788. Willd. *Sp. Pl.* v. 1. 611. Mart. *Mill. Dict.* v. 2. Sm. *Prod. Fl. Græc. Sibth.* v. 1. 98. Class and order, *Tetrandria Monogynia*. Nat. Ord. *Rubiaceæ*.

Gen. Ch. *Cal.* Perianth small, superior, in four deep, upright, acute, equal, permanent segments. *Cor.* of one petal, falver-shaped; tube elongated, quadrangular; limb in four deep, lanceolate, recurved segments. *Stam.* Filaments four, inserted into the tube towards the middle, awl-shaped, longer than the tube; anthers erect. *Pist.* Germen square, inferior; style thread-shaped, about as long as, or longer than the stamens; stigma obtuse, notched. *Peric.* Berry roundish, crowned with the calyx, having a furrow at each side, and consisting of two cells. *Seeds* solitary, hemispherical, striated.

Ess. Ch. Corolla of one petal, falver-shaped. Calyx in four deep segments. Style simple. Berry inferior, of two cells. Seeds solitary.

1. *E. littoralis*. Swartz. *Fl. Ind. Occ.* v. 1. 224. t. 4. Vahl. *Symb.* v. 2. 28. (*Thymelæa humilior, foliis acutis atrovirentibus*; Sloane *Jam.* v. 2. 93. t. 189. f. 1, 2.)—Stem square, smooth. Leaves nearly sessile, acute, with a spinous point. Gathered by Sloane, Browne, and Swartz, in Jamaica. The latter informs us that it grows in gravelly places by the shore, or on calcareous rocks. *Root* perennial. *Stems* procumbent, creeping, rather woody, with numerous, long, creeping or pendulous branches, which are straight, square, smooth, somewhat jointed, not much divided, but bearing numerous, alternate, short, leafy, simple, lateral branches. *Leaves* crowded, opposite, crossing each other

other in pairs, nearly sessile; about an inch or more in length, elliptic-lanceolate, acute at both ends, entire, very smooth, ribbed, rigid, of a dark green, tipped with a spinous point. *Stipulas* united with a stem between the very short foot-stalks, each crowned with three bristles, the middle one longest. *Flowers* axillary, solitary, sessile, yellowish. Many of them, according to Dr. Swartz, have no pistils.

2. *E. montana*. Sm. Fl. Græc. Sib. v. 2. t. 143, unpublished. Prod. n. 343. (*Asperula calabrica*; Linn. Suppl. 120. Willd. Sp. Pl. v. 1. 577. L'Herit. Stirp. v. 1. 65. t. 32. *Rubeola cretica foetidissima frutescens myrtifolia, flore magno suaverubente*; Tourn. Cor. 5.)—Stem round, downy. Leaves stalked, blunt, pointless.—Native of mountainous places in Crete, Sicily, and the south of Italy. Much smaller than the last, except in its *flowers*, which are larger, clustered about the ends of the branches, and of a fine rose-colour. The *stems* are much branched, woody, decumbent. *Leaves* on short stalks, opposite, about half an inch long, elliptic-lanceolate, bluntnish at both ends, entire, revolute, without any terminal spine, much more pliable than in the former; dark green above; pale beneath; roughish occasionally. When bruised they have a very disagreeable stercoraceous smell. *Stipulas* with a simple lanceolate point. *Branches* more or less downy when young.—Authors have greatly differed about the genus of this plant. By the older ones it has been taken for a *Rubia*, a *Valeriana*, a *Thymelea*, and a *Nerium* or *Oleander*; by modern writers it has been referred to *Asperula*, *Sherardia* and *Pavetta*. We hope to be nearer the truth than our predecessors; at least its technical generic characters agree well with Swartz's *Ernodea*, nor do we find any great discordance in the habit.—This beautiful plant emulates the *Daphne Cneorum* in colour and general aspect, and would be scarcely less admired in our gardens, to which it is, as yet, a stranger.

ERNSPACH, in *Geography*, a town of Germany, in the circle of Franconia, and principality of Hohenloe; six miles N. of Okringen.

ERNSTEIN, a castellated town of Germany, in the circle of the Lower Rhine, and electorate of Cologne; eight miles E. of Lintz.

ERNSTHOFEN, a town of Germany, in the circle of the Upper Rhine, and principality of Hesse Darmstadt; 10 miles S. of Darmstadt.

ERNSTTHAL, a small town of the kingdom of Saxony, in the county of Schonburg, close by Hohnstein, at the foot of a mountain called the Pfaffenberg, with a population of about 2000 individuals. It has a few cotton and linen manufactories.—Also, a small town of Germany, in the duchy of Saxe-Coburg, which has a considerable glass manufactory; in the space of thirteen weeks, or three calendar months, they make 216,000 glasses, 1000 of which used to be sold, in 1788, for 3½ rix dollars, or not quite twelve shillings sterling.

ERODINUM, a word used by some of the enthusiastic writers in alchemy, to signify the prognostic, good or bad, of any operation.

ERODIUM, in *Botany*, from *ερωδιος, a heron*, because the fruit resembles the head and beak of that bird. For a similar reason it is called in English Stork's-bill. L'Heritier. Geraniolog. unpublished. Ait. Hort. Kew. v. 2. 414. Sm. Fl. Brit. 727. Willd. Sp. Pl. v. 3. 625. Sibth. Oxon. 211. (*Geranium*; Linn. Gen. 350. Schreb. 458. Juss. 268. Gaertn. t. 79, *moschatum*.) Class and order, *Monadelphia Pentandria*. Nat. Ord. *Cruinales*, Linn. *Gerania*, Juss.

Gen. Ch. Cal. Perianth inferior, of five ovate, pointed,

concave, permanent leaves. *Cor.* Petals five, obovate, spreading, rather longer than the calyx, generally more or less irregular. *Nectary* of five glands between the petals. *Stam.* Filaments 10, awl-shaped, united by their base into a sort of cup; five of them fertile, nearly as long as the petals; the alternate five shorter and barren; anthers five, oblong, versatile. *Pist.* Germen superior, with five furrows, beaked; style central, awl-shaped, spirally furrowed, as long as the stamens, permanent; stigmas five, reflexed. *Peric.* Capsules five, aggregate, membranous, obovate, vertical, separating at their inside, sharp-pointed at their base, each tipped at its summit with a long, linear, flat, pointed, rigid awn, hairy on its inside, and at length spirally twisted, adhering by its ovate-oblong.

Eff. Ch. Calyx of five leaves. Petals five. Nectariferous glands five. Barren filaments five. Fruit beaked, of five aggregate capsules, each tipped with a long spiral awn, bearded on the inside.

Linnaeus in his *Genera Plantarum* had long ago indicated a division of his genus *Geranium* into several natural sections, distinguishable by characters in their fructification and inflorescence. The late learned botanist Monf. L'Heritier, pursuing the idea, divided that genus into three, each of them as naturally and distinctly defined as any in the whole system, and although the convulsions of his country, and his own premature death, prevented his publishing an elaborate work on the subject, he had fortunately conferred by letter with the intelligent editors of the *Hortus Kewensis*, and with the writer of the present article, so that his intention has been carried into effect, both in that work and the *Flora Britannica*. Of these three genera *Geranium* with its 10 fertile stamens, regular flower, and recurved naked awns, consists of what are usually called European *Geraniums*, bearing but one or two flowers on a stalk; *Pelargonium* with its seven fertile stamens, irregular flower, tubular nectary, and spiral bearded awns, comprehends what are generally called Cape *Geraniums*; while the present genus is made up of the Linnaean *Gerania cicutaria*.

Three species of *Erodium* are natives of Britain.

1. *E. cicutarium*. Engl. Bot. t. 1768. Hemlock Stork's-bill. (*Geranium cicutarium*; Linn. Sp. Pl. 951. Curt. Lond. fasc. 1. t. 51.) "Flower-stalks many-flowered; leaves pinnate; leaflets sessile, pinnatifid, cut." Common in waste ground. In sandy places near the sea its petals are generally white, or their usual rose-colour is elegantly diversified with a green spot on two or three of them. The herb is fetid, prostrate and annual, with finely divided leaves.

2. *E. moschatum*, Engl. Bot. t. 902. Musky Stork's-bill. (*Geranium moschatum*; Linn. Sp. Pl. 951.) "Flower-stalks many-flowered. Leaves pinnate; leaflets nearly sessile, elliptical, unequally cut." Wild in the mountainous pastures of Yorkshire and Westmoreland, but in other places it is usually the outcast of gardens, where it has often been cultivated for the sake of the strong musky scent of its herbage. The *flowers* are smaller and less ornamental than those of the preceding; *leaves* larger, paler, and more viscid.

3. *E. maritimum*, Engl. Bot. t. 646. Sea Stork's-bill. (*Geranium maritimum*; Linn. Sp. Pl. 951.) "Flower-stalks barely three-flowered. Leaves heart-shaped, cut, crenate, rough. Stems depressed." Native of sandy sea-shores in various places, flowering all summer long. When brought into a garden it becomes wonderfully luxuriant. The *root* is perennial. *Petals* white or reddish, for the most part much smaller than the calyx leaves.

Willdenow has 34 species of this genus in all. Most of them

them abound in the warmer countries of Europe, and the northern part of Africa, and several are cultivated with us for ornament, as *E. gruinum*, (*Geranium creticum*; Ger. em. 943), a hardy annual with large blue flowers; *E. hymenodes*; Andr. Repof. t. 413, which requires a greenhouse, and is perennial. Three species are natives of the Cape of Good Hope, viz. the most beautiful *E. incarnatum*, Ait. H. Kew. v. 2. 415. Curt. Mag. t. 261. (*Geranium incarnatum*; Linn. Suppl. 306.) This is a tender greenhouse plant, and therefore not very common, but worthy of all attention for the delicate hues, and eye-like pencilling, of its blossoms. The other two Cape species are *arduinum*, (*Geranium arduinum*; Linn. Sp. Pl. 952.) very little known to botanists, and never introduced into the gardens of Europe; and *ribifolium*, Jac. Ic. Rar. v. 3. t. 509.) an inconspicuous flower, not much likely to excite the attention of cultivators.

**ERODIUS**, in *Entomology*, a genus of the Coleopterous kind, established by Fabricius. These insects are generically distinguished by the following character: the antennæ moniliform; feelers four; jaws horny, truncated, and bifid; lip horny and emarginate. This is the Fabrician definition, to which may be added that the body is roundish, gibbous, and emarginate; thorax transverse; wing-cases closely united, and longer than the abdomen.

#### Species.

**TESTUDINARIUS**. Black; wing-cases rough, the sides covered with whitish dust. Fabr.

An insect of large size, found at the Cape of Good Hope; the wing-cases are very gibbous, with small raised dots.

**GIBBUS**. Black; wing-cases with three raised lines. Fabr. Remarkable for the gibbosity of its form, and the obtusity of the wing-cases; it is of moderate size; and has the anterior shanks armed with a strong tooth in the middle and at the tip. The species inhabits Arabia.

**PLANUS**. Black; wing-cases with a single raised line. Fabr.

Native of the same country as the former. The anterior shanks not armed with a spine.

**MINUTUS**. Black; wing-cases perfectly smooth. Fabr.

Small thorax with two impressed dots on the back; legs unarmed. Inhabits the eastern parts of the world.

**MURICATUS**. Gibbous, black; wing-cases muricate. Fabr.

A species described in the Fabrician Suppl. Ent. from the cabinet of Lund. It is a native of the Cape of Good Hope; in size and appearance resembles *E. gibbus*. The head and thorax smooth.

**EROPHEEVO**, in *Geography*, a town of Russia; in the government of Irkutsch; 60 miles N. of Balaganskoi.

**EROS**, of *eros*, love, in *Mythology*, one of the two chiefs over all the other cupids, being the cause of love. See **ANTEROS**.

**EROSION**, in books of *Surgery*, we often find this expression used synonymously with the term ulceration.

**EROSION**, in *Geology*, according to Mr. Kirwan, (*Geol. Ess.* 230 and 285,) denotes a solution or melting of the softer calcareous particles by water, by which he accounts for the formation of the vast caverns and grottos to be found in the Derbyshire lime-stone rocks, and those of other countries. M. de Saussure, in his *Agenda* (*Journal des Mines*, N<sup>o</sup> 2c.) directs the attention of geological travellers to the sides of valleys (§ 12.) to search for the vestiges of the erosion of water: by which we might understand a mechanical sweeping or washing away of strata, as well as a solution or melting as above.

**EROSUM FOLIUM**, among *Botanists*. See **LEAF**.

**EROTESIS**, *Ἐρωτησις*, in *Rhetoric*, the same figure with *Interrogation*. Every interrogation or question is not figurative; but it becomes figurative, when the same thing may be expressed in a direct manner; but the putting it by way of question gives it much greater life and spirit. As when Cicero says, (in *Catal.* i. c. 1.) "Cataline, how long will you abuse our patience? Do not you perceive your designs are discovered?" He might have said, "You abuse our patience a long while; you must be sensible your designs are discovered." But it is evident how much this latter mode of expression falls short of the force and vehemence of the former. Thus also, when Medea says, "I could save; and do you ask, if I can destroy?" Had she merely said, "I could save, and I can destroy," the sentence would have been flat, and very unfit to express the rage and fury in which the poet there represents her. (*Quint. Inst. Orat.* l. viii. c. 5.) This figure is suited to express most passions and emotions of the mind, as anger, disdain, fear, desire, &c. It serves also to press and bear down an adversary. This figure likewise diversifies a discourse, and gives it a beautiful variety, by altering the form of expression, provided it be neither too frequent, nor continued too long. Besides, the warm and eager manner in which it is expressed enlivens the hearers, and quickens their attention.

**EROTEUM**, in *Botany*, perhaps from *ἑρωτίζω*, to question, in allusion to its doubtful nature at first sight, being very like *Thea* till the fruit is investigated. Swartz. *Prod.* 5. The author, however, being himself, as it seems, dissatisfied with this name, has, in his *Fl. Ind. Occ.* v. 1. 971, changed it to **FREZIERA**, which see.

**EROTIA**, *Ἐρωτία*, a festival among the Greeks, in honour of Cupid, being celebrated every fifth year with sports and games.

**EROTIANUS**, in *Biography*, the author of a glossary, containing an explanation of all the words used in the writings of Hippocrates, lived in the first century of the Christian era, in the reign of Nero, and dedicated his work to Andromachus of Crete, who was physician to that emperor. It was printed at Venice, in 1566, in 4to. with the notes of Barth. Eustachius, under the title of "Vocum, quæ apud Hippocratem, collectio, et ejus operum in septem sectiones distributio." The glossary of Erotian was also annexed to the edition of Hippocrates, published by Foesius at Geneva, in 1657. Haller. *Bibl. Med. Eloy.*

**EROTIC**, derived from *ἔρως*, love; whence *ἑρωτικός*, is applied to any thing which has a relation to the passion of love.

In *Medicine*, we particularly use the phrase delirium eroticum, for a kind of melancholy contracted through excess of love.

Though, among the several species of pulses, there be no amorous pulse, that is, no pulse peculiar to that passion; yet we can certainly discover where the disorder is erotic, by the beating of the pulse, which, in that case, is changeable, unequal, turbulent, and irregular. Speak to the patient of the person he loves, and his pulse instantly changes, becoming higher and quicker; and the minute you change the conversation, the pulse is lost again, and is disturbed anew.

**EROTIDIA**, *ἑρωτιδία*, the same with *erotia*.

**EROTOMANIA**, in *Medicine*, a term used by some writers to denote that modification of insanity, of which the passion of love is the origin, and in which the love of a particular individual constitutes the predominant idea. Sauvages treats of this form of derangement under the name of *melancholia amatoria*; (see his *Nofol. Meth. Class.* viii. Gen. xix. Spec. 2.) Sennertus under that of *amor*

*infans*, &c. The word is derived from *ignis*, love, and *manus*, mania, madness.

This disease is distinguished from satyriasis and nymphomania, if indeed such maladies have any existence, inasmuch as the patient, so far from being urged by libidinous desires, contemplates the object of his affection with reverence and distant admiration, as if he were a divinity; he would spend his days in doing homage to her perfections, and deems food, sleep, and the affairs of the world of little comparative moment. As a remedy for this species of insanity, low and light diet has been recommended. Ovid has advised the performance of a long journey, during which a constant change of scene, and the absence of all objects, with which the recollection of the individual beloved, might tend to restore the mind to its usual condition: constant occupation of body or mind, "qui vis sanari, res age, tutus eris;" and the admonitions of the wife in regard to the loss of health, fortune, and character, which must attend such hallucination, have also been suggested. The former part of the advice may be sometimes beneficial, but those who are most experienced in the treatment of the insane, well know how little benefit is produced by reasoning with madmen. See MELANCHOLY.

EROTYLOS, in *Natural History*, the name of a stone, of which we have no description left us, but which the ancients are said to have used in divination.

EROTYLUS, in *Entomology*, a genus of Coleoptera in the Fabrician system, allied, and in some degree confounded, with the two Linnæan genera *Chrysomela* and *Coccinella*, and arranged by Gmelin under that of *Cryptocephalus*. The antennæ are filiform; feelers four and unequal, the anterior longer and hatchet-shaped; jaws horny and bifid; lip horny, short, dilated at the tip, truncated, and somewhat emarginate; body suboval. The transformations of these insects are unknown, in the perfect state they are found generally on flowers. Three of the species are described by Linnæus, the remainder principally by Fabricius.

Species.

GIGANTEUS. Oval, black; wing-cases with numerous fulvous dots. Fabr. *Chrysomela gigantea*, Linn. *Coccinella gigantea*, Sulz. Native of India.

CANCELLATUS. Black; wing-cases yellow, reticulated with black. Fabr. Large and roundish; inhabits Brazil.

HISTRIO. Deep black; wing-cases barred with black and yellow, a scarlet spot at the base and tip. Fabr.

A species of large size, an inhabitant of Cayenne.

LUGUBERIS. Testaceous; antennæ and shanks black. Fabr. Native of America.

GIBBOSUS. Black; wing-cases yellowish with black dots; band in the middle and at the end black. Fabr. *Chrysomela gibbosa*, Linn. *Coccinella*, Gronov.

An insect of considerable magnitude, the wing-cases of which are remarkably gibbous, and the thorax impressed on each side; it is a native of South America.

6-FASCIATUS. Oval, black; wing-cases with six waved fulvous bands, the anterior one interrupted. Fabr.

Inhabits Cayenne.

NOTATUS. Black; wing-cases with a yellow band in the middle spotted with black, and marked with red at the base. Fabr. Native of South America.

CONCATENUS. Black; wing-cases reticulated with yellow and black, and marked with two black bands. Fabr. Mant. Inf. Country unknown; the body large.

5-PUNCTATUS. Oval; wing-cases black with five red dots. Fabr. Inhabits America.

PUNCTATISSIMUS. Black; wing-cases yellow with numerous black dots. Fabr.

Described from the Hunterian cabinet: an American species.

VARIUS. Black; wing-cases punctured, spotted with fulvous in the middle. Fabr. Inhabits Surinam.

GEMMATUS. Black; wing-cases with numerous fulvous dots; thorax variolous. Fabr.

An insect of moderate size, found in Cayenne.

MACROCHEIROS. Black; wing-cases with alternate black and yellow bands; fore legs very long. Fabr.

Native of India.

ABDOMINALIS. Black; wing-cases yellow with four waved black bands and a distinct black dot. Fabr.

A Brazilian species, in size resembling *E. fasciatus*, and having the abdomen yellow with two lines of black dots.

FASCIATUS. Black; wing-cases with three yellowish bands. Fabr.

From the Banksian cabinet: the native place unknown: size moderate.

ZEBRA. Yellowish; head, base of the thorax, and three bands on the wing-cases with the legs black. Fabr. Mant.

ALTERNANS. Black; wing-cases with two yellow bands, the anterior one dotted with black. Fabr.

SURINAMENSIS. Black; wing-cases red and immaculate. Fabr. Native of Surinam.

LIMBATUS. Oblong, black; margin of the thorax and border of the wing-cases yellow. Fabr.

South American species; head yellowish with a black frontal spot; thorax smooth with a broad sinuate lateral margin.

NEBULOSUS. Black; thorax, and wing-cases varied with ferruginous. Fabr.

Inhabits the same country as the preceding.

DILATATUS. Oblong, black; thorax and wing-cases ferruginous. Fabr.

Native of the Cape of Good Hope. The antennæ are brown, at the base ferruginous; wing-cases smooth; and much broader than the body.

MORIO. Oblong, black, and immaculate. Fabr.

This, and the four following species, are natives of New Holland. These are described by Fabricius from the Banksian cabinet, and are represented in the volume of "Donovan's General Illustration of Entomology, devoted to the Insects of the Australasian regions."

SMARAGDULUS. Oblong, black; wing-cases striated and green.

AMETHYSTINUS. Oblong, black; thorax and wing-cases blue; resembles the last; front retuse; wing-cases with punctured striae.

BICOLOR. Oblong, black; bronzed above.

CUPREUS. Oblong, black; thorax and wing-cases coppery.

RUFIPES. Oblong, black; legs pitchy. Fabr. Mant. Inhabits Kiel.

FLAVIPES. Oblong, glossy green; antennæ and legs yellowish. Native of Jamaica, in the Banksian cabinet.

EROWA, the name of a kind of nettle which grows in the mountains at Otaheite in the South Sea, with which the inhabitants make fishing lines, which serve to hold the strongest and most active fish, and are much stronger than our silk lines of twice the thickness.

See ERBACH, in *Geography*.

ERPENIUS, THOMAS, in *Biography*, was born at Gorcum, in Holland, in the year 1584. His parents, natives of Bois-le-Duc, were, on account of their conversion to the Protestant religion, obliged to withdraw from that place, to one more favourable to the rights of private judgment. They provided their son with a good education in the rudiments of learning, and when they discovered in him a pro-

penity for literary pursuits they sent him to Leyden, where he felt so dissident of succeeding in his studies, that for some time he determined to relinquish them. Fortunately his desire for knowledge overcame his modesty, and he applied himself with so much diligence, that he obtained the highest praise of his different tutors, and excited their surprize at his extraordinary progress. He excelled in metaphysics, but his fame with posterity is built on the skill which he acquired in the oriental languages. After availing himself of all the advantages which the university of Leyden afforded, he travelled for farther improvement in foreign countries. In England he became acquainted with Bedell, who was celebrated for his knowledge in Hebrew and rabbinical learning. In France he improved himself in his knowledge of the Arabic tongue; and in Italy he improved his acquaintance with the Hebrew language, by conversing with some learned Jews, and made himself master of the Persian, Turkish, and Ethiopic tongues. After spending several years in foreign countries, Erpenius returned to Holland, where he was elected professor of the oriental languages in the university of Leyden. This was in the year 1612, and very shortly after his appointment he set up a press for the printing of works in the Eastern literature. In the year 1620 he was sent by the States General on different journeys into France, to engage Peter du Moulin, or Andrew Rivet, to undertake the theological professorship at Leyden. After this he was appointed oriental interpreter to the States, and was employed to translate the letters addressed to them from Asia and Africa, and to write such as were sent by them to the sovereigns in those parts of the world. He was frequently invited into Spain by the sovereign of that country, to explain certain inscriptions in the Arabic language on the Moorish buildings and monuments in that country, and the emperor of Morocco is said to have been highly pleased with the purity and beauty of his style, and to have exhibited his letters as objects of real curiosity. He died in the year 1624, when he was only 48 years of age. His works are numerous, and have given him a high reputation among the learned. They are enumerated by Moreri, and other biographical writers, and we are informed that he projected an edition of the Koran, with a Latin version and notes, likewise an Arabic grammar and lexicon, which his death prevented him from executing. Gerard-Jean Vossius pronounced over him a funeral oration. Moreri.

ERPIS, or HERPIS, in *Ancient Geography*, a town of Africa, in Mauritania Tingitana. Ptolemy.

ERRA, in *Geography*, a town of Portugal, in the province of Estremadura, on a river of the same name; 22 miles S.E. of Santarem.—Also, a river, which runs into the Latas, 12 miles E. of Salvateira; in the province of Estremadura.

ERRABARI, a town of Egypt; 10 miles N.W. of Cairo.

ERRAINE, a town of Egypt; two miles E. of Tahta.

ERRANT, in *Law*, the same with itinerant; the term is attributed to judges who go the circuit; and to bailiffs at large.

ERRANTS, *knight*. See KNIGHT.

ERRATA, a list usually placed at the beginning or end of a book, containing the faults that have escaped in the impression, and, sometimes, even in the composition of the work.

Lindenberg has an express dissertation on typographical errors, "De Erroribus Typographicis;" in which he observes, that there is no book exempt from them, not

even the sacred books. He sets himself to enquire into all the causes thereof; and proposes means to prevent them, but he advances nothing on that article but what is either common, or impracticable.

ERRATIC, in *Astronomy*, an epithet applied to the planets, which are called erratic, or wandering stars, in contradistinction to the fixed stars.

ERRATIC fevers, in *Medicine*, a term used to express such fevers as, according to the language of medical writers, observe no regular type, that is, are not determinate either in their attacks, or in their general period. They are thus called by way of distinction from the typic fevers, which are regular in both. See FEVER.

ERRATIC winds. See WIND.

ERRHINE, in the *Materia Medica*, from *er*, *in*, and *rhin*, the nose, is a term applied to those substances which are introduced into the nose, for the purpose of exciting a discharge from the passages. When they excite sneezing, the medicines of this class have been called ptarmica, and sternutatories; and, from the discharge which they occasion, they have been termed apophlegmatica, and, in barbarous Latin, caput-purgia.

Errhines, by stimulating the exhalent vessels and the mucous follicles of the Schneiderian membrane, which lines the internal surface of the nose, and the cavities adjoining it, excite those vessels and follicles to pour out their fluids more copiously than usual. The discharge is sometimes of a mucous, and sometimes of a thinner fluid; it is often attended with sneezing, but sometimes is procured without. This, however, implies no difference in the operation, except as to the stronger or weaker irritation of the medicine employed. For although when sneezing is excited a larger evacuation is often produced, yet the effects of errhines are not altogether proportional to the sensible irritation which they occasion. See Alston, *Mat. Med.* vol. i. sect. 8.

The evacuation produced by these medicines consists not merely in emptying the mucous follicles of the lining membrane of the nose of their contents, but in augmenting the secretion: whence, agreeably to the laws of the circulation, a greater afflux of fluids to those parts is necessarily occasioned, and therefore a diminution of the fluids in the neighbouring vessels. In this way Dr. Cullen explains the fact, that errhines often give relief to rheumatic pains in the neighbouring parts, especially to the tooth-ach, as well as to some forms of head-ach, pains of the ear, and ophthalmia. "How far their effects may extend," he says, "cannot be exactly determined; but it is probable that they may operate more or less on the whole vessels of the head, as even a branch of the carotid passes into the nose: and independent of this, it is not improbable that our errhines may have been of use in preventing apoplexy and palsy; which at least is to be attended to so far, that whenever any approach to these diseases is suspected, the drying up of the mucous discharge should be attended to, and, if possible, restored." Cullen's *Mat. Med.* vol. ii. p. 436.

The nicotiana, or tobacco, as it is commonly prepared for persons who amuse themselves by snuffing, may be conveniently employed, with people unaccustomed to it, as an errhine; but repetition soon diminishes its power, and renders it useless. It produces a different degree of discharge in different people, even of those who use it habitually; and Dr. Cullen states, from his own experience, "that whenever the discharge has been considerable, the laying aside snuffing, and therefore suspending that discharge, may have very bad effects."

The article most commonly employed as an errhine, is the *Asarum esarabacca*, snuffed up the nose every evening, for a short time, in the quantity of three grains. Quincy observes,

erves,

*Serves*, that its pungency is not immediately felt upon taking, but after some time it makes the nose run very much. In larger quantities it sometimes brings blood, and even occasions a swelling of the whole head. This last effect, however, has been oftener produced by the *Euphorbium*, a still more acrid errhine. Dr. Cullen, speaking of these severe effects, says, "I have seen some instances of megrims, ophthalmias, and particularly tooth-achs, cured by the violent operation of errhines; but I never thought it safe to imitate the practice." The *white hellebore*, in very small quantity, is also an acrid errhine.

ERRIFF, in *Geography*, a province of Africa, in the country of Fez. See RIF.

ERRIPSIS, from *εἶπω*, *I precipitate*, in *Medicine*, is used in different senses, sometimes for a weakness of the whole body, sometimes only of some one part. When applied to the whole body, it expresses that utter dejection and prostration of strength which makes a man fall down like a dead carcass; and, when applied to the eyes, it expresses such a debility, as renders it impossible to keep them open.

ERROAD, in *Geography*, a town of India, in the country of Coimbatore; 39 miles E.S.E. of Damicotta, and 48 N.E. of Coimbatore.

ERROL, a small uninhabited town of America on lake Umbagog, on the north-easternmost settled part of Grafton county, in New Hampshire, incorporated in 1774.

ERROMANGO, an island in the Southern Pacific ocean, being one of those called the "New Hebrides," 18 leagues from Sandwich island, and 24 or 25 leagues in circuit. The middle of it lies in S. lat.  $18^{\circ} 54'$ . E. long.  $169^{\circ} 19'$ , and it is of a good height. Captain Cook anchored in a bay of this island; and he found that although the behaviour of the inhabitants was at first friendly, their real intentions were very different. They were armed with clubs, spears, darts, bows and arrows, and seemed determined to employ them in a hostile manner. On this account it became necessary for the captain to give orders to his men to fire upon the assailants. At length they were so terrified as to withdraw and make no farther appearance. Those islanders, it was observed, seemed to be of a different race from those of Mallicollo, and they spoke a different language. They are of a middle size, with a good shape, and tolerable features. Their colour is very dark, and their aspect is not improved by their custom of painting their faces, some with a black, and others with a red pigment. Their hair is curly and crisp, and somewhat woolly. The few women, who were seen and who appeared to be ugly, wore a kind of petticoat, made either of palm leaves, or of a similar plant; but the men, like those of Mallicollo, were almost entirely naked. On account of the treacherous behaviour of the inhabitants of Erromango, captain Cook called a promontory, or peninsula, near which the skirmish happened, "Traitor's Head." This is in the N.E. point of the island, and is situated in S. lat.  $18^{\circ} 43'$ , and E. long.  $169^{\circ} 28'$ .

ERRONAN, or FOOTOONA, the most eastern island of all the Hebrides, appeared to captain Cook to be about five leagues in circuit, of a considerable height, and flat at top. On the N.E. side is a little peak seemingly disjoined from the isle; but which was thought to be connected by low land. It is distant in the direction of N. by E.  $\frac{1}{2}$  E. 11 leagues from Port Resolution in the island of Tanna.

ERROR, a mistake of the mind in giving assent to a thing, or proposition, which is not true. See FALLACY.

Some philosophers define error an act of the mind, whereby things that should be joined are separated; or, things that should be separated, are joined; or a wrong judgment, disagreeing with the things whereon it is passed.

Error stands in opposition to truth, which consists in an agreement between the proposition and the thing whereof it is affirmed or denied.

However, a bare failure, or non-attainment of truth, does not constitute error; that being common both to ignorance and doubting.

Error only stands distinguished from *falsehood*, in that the former is in the mind, and the latter only in the proposition.

The great origin of all error, *i. e.* of believing that to be true which is false, is a liberty, or power, in the human mind, of giving its assent to ideas, to propositions, that are obscure, as if they were perspicuous and plain.

Particular causes of error are, inadvertency, ignorance, impatience, interest, authority, education, &c. See FAITH, PROBABILITY, OPINION.

Against all which, there is this one general rule or caution laid down by F. Malebranche and others; *viz.* never to give our full assent to any proposition, unless the evidence for it be so strong, as that we can no longer withhold it, without incurring the secret reproaches of our own reason.

Mr. Locke reduces the causes of all our errors to these four; *viz.* 1. Want of proofs. 2. Want of ability to use them. 3. Want of will to use them. And, 4. Wrong measures of probability.

F. Malebranche considers five occasional causes of error, or rather of five different kinds of errors, accommodated to the different manners we have of perceiving things. 1. Errors of sense. 2. Of the imagination. 3. Of the understanding. 4. Of our inclinations. And, 5. Of the passions. See SENSE, IMAGINATION, UNDERSTANDING, INCLINATION, and PASSION.

ERRORS, *popular*. See POPULAR.

ERROR, in *Law*, generally denotes a fault, or oversight, either in pleading, or in process; upon either of which is brought a writ, by way of remedy, called a *writ of error*; in Latin, *de errore corrigendo*.

A writ of error lies for some supposed mistake in the proceedings of a court of record; for, to amend errors in a bafe court, not of record, a writ of "false judgment" lies. The writ of error only lies upon matter of law arising upon the face of the proceedings; so that no evidence is required to substantiate or support it; there being no method of reversing an error in the determination of *facts*, but by an attain, or a new trial, to correct the mistakes of the former verdict. A writ of error may be brought for notorious mistakes in the judgment or other parts of the record; as where a man is found guilty of perjury, and receives the judgment of felony, or for other less palpable errors, such as any irregularity, omission, or want of form in the process of outlawry, or proclamations; the want of a proper *addition* to the defendant's name, according to the statute of additions; for not properly naming the sheriff, or other officer of the court, or not duly describing where his county or court was held; for laying an offence committed in the time of the late king, to be done against the peace of the present; and for many other similar causes, which (though allowed out of tenderness to life and liberty) are not much to the credit or advancement of the national justice. These writs of error to reverse judgments in case of misdemeanors are not to be allowed of course, but on sufficient probable cause shewn to the attorney-general; and then they are understood to be grantable of common right, and "ex debito justitiæ." But writs of error to reverse attainders in capital cases are only allowed "ex gratia;" and not without express warrant under the king's sign manual, or at least by the consent of the attorney-general. 1 Vern. 170. 175.

If a writ of error be brought to reverse any judgment of an inferior court of record, where the damages are less than ten pounds; or, if it is brought to reverse the judgment of any superior court after verdict, he that brings the writ, or that is plaintiff in error, must (except in some peculiar cases) find substantial pledges of prosecution, or bail (stat. 3 Jac. I. c. 8. 13 Car. II. c. 2. 16 and 17 Car. II. c. 8. 19 Geo. III. c. 70.): to prevent delays by frivolous pretences to appeal; and for securing payment of costs and damages, which are now payable by the vanquished party in all, except a few particular instances, by virtue of the several statutes here recited. 3 Hen. VII. c. 10. 13 Car. II. c. 2. 8 and 9 W. III. c. 11. 4 and 5 Ann. c. 16.

A writ of error lies from the inferior courts of record in England into the king's bench, and not into the common pleas. (Finch. L. 480. Dyer 250.) Also from the king's bench in Ireland to the king's bench in England. It likewise may be brought from the common pleas at Westminster to the king's bench; and then from the king's bench the cause is removable to the house of lords. From proceedings on the law side of the exchequer a writ of error lies into the court of exchequer chamber, before the lord chancellor, lord treasurer, and the judges of the court of king's bench and common pleas; and from thence it lies to the house of peers. From proceedings in the king's bench in debt, detinue, covenant, account, case, ejectment, or trespass, originally begun there by bill (except when the king is party) it lies to the exchequer chamber, before the justices of the common pleas, and barons of the exchequer; and from thence also to the house of lords (stat. 27 Eliz. c. 8.); but when the proceedings in the king's bench do not first commence therein by bill, but by original writ sued out of chancery, this takes the case out of the general rule laid down by the statute (1 Roll. Rep. 264. 1 Sid. 424. 1 Saund. 346. Carth. 180. Comb. 295.); so that the writ of error then lies, without any intermediate stage of appeal, directly to the house of lords, the dernier resort for the ultimate decision of every civil action. Each court of appeal, in their respective stages, may, upon hearing the matter of law in which the error is assigned, reverse or affirm the judgment of the inferior courts; but none of them are final, save only the house of peers, to whose judicial decisions all other tribunals must therefore submit, and conform their own. Blackit. Com. book iii.

**ERROR, to assign.** See **ASSIGN.**

**ERRORS, Clerk of the.** See **CLERK.**

**ERROR loci**, literally *error of place*, a doctrine of considerable importance in the theory of diseases, taught by the celebrated Boerhaave. It was deemed the principal cause of those obstructions to the circulation of the blood, on which inflammation, in all its varieties, was supposed to depend. "The parts of a fluid," says Boerhaave, "become unable to pass by error of place (per errorem loci), when a corpuscle rushes into the dilated mouth at the basis of a conical canal, and cannot pass through the narrow end of it." (Aphorism 118.) This doctrine is founded upon these three circumstances; the series of particles, of which the blood is composed; the series of progressively diminishing vessels; and the conical form of these vessels: and it is thus explained by the comment of Van Swieten.

The largest particles in the blood are the red globules, which are to be found naturally in the larger vessels only. Now the extremities of the arteries carrying red blood, transmit the red globules singly, according to the observations made with microscopes on the pellucid parts of living animals. The finer parts of the blood are conveyed into the smaller lateral vessels, and the red vein receives the red blood

only. The vessel of the next magnitude receives all the fluids except the red globules, and retaining the larger particles only, (*viz.* the serous globules) transmits the remaining thinner liquids into the still smaller vessels, that arise from the serous artery. This law obtains, then, in all the decreasing series of vessels. The red arteries can receive and transmit all the humours; the serous arteries exclude the red part of the blood, but transmit the serous globules, and every other thinner fluid, and so on. Now, should the diameter of a lateral vessel arising from a larger one be by any means increased, for example, the aperture of a serous artery, which arises from a red one, a red globule might be able to enter its orifice when thus dilated; but as a conical canal always grows narrower, it will shortly stick fast, and be by no means able to pass through its extremity, and consequently will cause an obstruction, as the bulk of the particle to be carried through exceeds the capacity of the transmitting vessel.

This error loci of the fluids was considered as the proximate cause of inflammation by Boerhaave, and his commentator illustrates the dilatation and distention of the lymphatic and serous vessels by the red blood in the case of inflammations of the eye; in which the vessels of the surface of the eye, which are naturally transparent, become red, and visible, sometimes even giving a red colour to the whole of the surface. See Van Swieten, Comment. ad Aph. 118—378, &c.

**ERRUCA**, in *Ancient Geography*, a town of Italy, belonging to the Volsci, according to Diodorus Siculus.

**ERSE**, in *Geography*, a river of Germany, in the circle of Lower Saxony, which runs into the Fuhse; 8 miles S. of Zelle.

**ERSH**, in *Agriculture*, is a term signifying land in the state of stubble after the grain has been taken off. Hence we have pea, bean, and different sorts of grain ershes.

**ERSH-CROP**, is such a crop as is grown after some of these sorts of stubbles have been turned down by the plough.

**ERSTEIN**, in *Geography*, a small town of France, in the department of the Lower Rhine, chief place of a canton in the district of Barr, with a population of 2344 individuals. The canton contains 14 communes and 8991 inhabitants, on a territorial extent of 137½ kilometres.

**ERTA**, a town of Asia, in Parthia.

**ERTHOLM**, a small island, about three leagues from the coast of Schoonem, and half a league from Bornholm. It belongs to the Danes; and till of late was garrisoned only with 50 men: the force has been since augmented to 500. This island may be easily captured and retained by that power, which, during the interval of naval operations in the Baltic, has the superior fleet.

**ERTO DEL FERRO**, a town of Italy, in the kingdom of Naples, and province of Calabria Citra; 10 miles W. of Umbriatico.

**ERTZGEBIRGE**, or rather **ERTZGEBURGE**, (arch-mountainous country,) is the fifth of the seven circles into which that part of the kingdom of Saxony, which is called Saxony Proper, or formerly Electoral Saxony, is divided. As late as the tenth century this whole extensive tract of mountainous country was nothing but an impervious forest, called Miriquido, or Miriquidvi, few spots of which began to be cleared in 1004. It is bounded to the north by the circles of Misnia, or Meissen and Leipzick, and by the principality of Altenburg, to the west by the same principality, the circles of Neustadt and Voigtland, and the dominions of the princes of Reufs; to the south and east by the kingdom of Bohemia. Its principal rivers are the Zschopau, the Flöhe, the Pöhl, the Presnitz, and the Schwartzwasser.

The

The territorial extent of the Ertzgebirge is 121 German square miles, and its population, in 1785, amounted to 405,600 individuals, which gives 3332  $\frac{1}{3}$  inhabitants to the German square mile. It produces corn, potatoes, vegetables of all sorts, and excellent flax, and has several manufactories, but chiefly those which work upon minerals and metals.

The circle of the Ertzgebirge is remarkable for its numerous and valuable mines, which, in 1789, employed 12,867 miners, and, in 1788, yielded in silver only 50,618 marks. The aggregate of all the metals produced the sum of 700,640 dollars. Amalgamation, or application of mercury to extract the silver from the ore, was first introduced in the Saxon mines in the year 1787.

Freyberg is the chief place of the Ertzgebirge, and the first town in Europe for the study of mineralogy. See FREYBERG.

The whole circle of the Ertzgebirge contains 61 towns and 723 villages. It is subdivided into 13 districts, viz. Freyberg, Augustsburg, Chemnitz, Rossien, Frauenstein, Altenberg, Lauterstein, Wolkenstein, Annaberg, Grünhayn, Schwartzberg, Weissenburg, and Zwickau.

ERTZICA, a town of Asia Minor, in Cappadocia, commonly called *Arzingham*.

ERUBRUS, a river of Gaul, thought by M. D'Anville to be the Rouver, which runs into the Moselle, a little below Treves.

ERUCA, in Zoology. See CATERPILLAR.

ERUCA marina griseo fusca. See APHRODITA.

ERUCAGO, in Botany, Tourn. Inst. 232. t. 103, see BUNIAS, spec. 3.

ERUCTATION, BELCHING, the same as ructation.

ERUDITION, denotes learning or knowledge; and chiefly that of history and antiquity, of languages and of books, which is the result of hard study, and extensive reading. The Scaligers were men of deep erudition: the writings of M. Launoy, a priest of the Oratory, are full of erudition.

Mr. Locke says, it is of more use to fill the head with reflections than with points of erudition. If the mind be not just and right, ignorance is better than erudition, which only produces confusion and obscurity. M. Balzac calls a heap of ill chosen erudition the luggage of antiquity.

ERVEDEIRA, in Geography, a town of Portugal, in the province of Estremadura; 12 miles N.N.W. of Leiria.

ERVILIA, in Botany, an ancient name for a kind of vetch or pea. See PISUM OCHRUS, also ERVUM.

ERUPA, in Ancient Geography, a town of Arabia Deserta. Ptolemy.

ERUPTION, in general, a bursting forth, or exclusion of something which was before covered, or concealed.

The eruption of volcanos, or burning mountains, is frequently the effect and issue of earthquakes. See EARTHQUAKE, VOLCANO, &c. For an account of the eruptions of mount *Ætna* and *Vesuvius*, see *ÆTNA* and *VESUVIUS*.

ERUPTION, in Medicine, denotes the appearance of various spots and discolourations of the skin, whether pustules, pimples, rashes, &c.: thus, we speak of an eruption of small-pox, or of measles; and, by a figure of speech, these pustules, rashes, &c. are often denominated eruptions, or cutaneous eruptions.

ERUPTION in Infants. See INFANTS.

ERUPTIVE DISEASES, a term nearly synonymous with CUTANEOUS DISEASES, (which see). Eruptive fevers are those febrile diseases which are accompanied by an eruption of spots or tumours on the skin, by which they are principally characterized: such as small-pox, measles,

chicken-pox, cow-pox, scarlet fever, erysipelas, shingles, &c.

ERVUM, in Botany, an ancient Latin name of unknown derivation. Tare. Linn. Gen. 376. Schreb. 498. Willd. Sp. Pl. v. 3. 1112. Sm. Fl. Brit. 775. Juss. 360. Class and order, *Diaadelphica Decandria*. Nat. Ord. *Papilionacea*, Linn. *Leguminosæ*, Juss.

Gen. Ch. Cal. Perianth of one leaf, tubular, erect, cloven half-way down into five acute segments, all of equal breadth, but the lowermost is rather the longest. Cor. papilionaceous, twice as long as the calyx: standard obovate, nearly entire, ascending, with a broad claw, compressed and keeled at the back; wings two, oblong, obtuse, half heart-shaped, shorter than the standard, with narrow claws; keel as long as the wings, of two conjoined compressed petals, with separate claws. Stam. Filaments in two sets, one composed of nine, the other solitary; anthers roundish, two-lobed, erect. Pist. Germen superior, oblong, compressed, horizontal; style simple, ascending, forming a right angle with the germen, and about half as long; stigma capitate, obtuse, hairy all over. Peric. Legume oblong, obtuse, compressed, rigid, knotty from the prominent seeds, of one cell, and two pointed, spirally-elastic valves. Seeds from two to four, occasionally more, roundish, somewhat compressed.

Ess. Ch. Stigma capitate, hairy all over.

The genus *Ervum* in Linnæus is a heterogeneous assemblage, difficult to be accounted for. *E. Lens*, the species from which his generic character seems to have been principally taken, is most completely a *Cicer*, under which head it should have been described in our eighth volume. *E. soloniense* is not only a true *Vicia*, but the very same plant with *Vicia lathyroides*, Linn. Sp. Pl. 1040. See Engl. Bot. t. 30. *E. monanthos* and *Ervillea*, having the style hairy on the upper side, appear to us to belong to *Lathyrus*. Thus none of the Linnæan *Erva* remain, except our two British species, and these are not only very peculiar in habit, but according to the analogy of the tribe to which they belong, their stigma affords an excellent essential character, not to be found in any other *diadelphous* flower. All this was first explained in the *Flora Britannica*, by the author of the present article, and Willdenow has adopted it in every point, except that he retains the old erroneous character, "calyx deeply five-cleft," in addition to that derived from the stigma, and also makes *E. Ervillea* a *Vicia*. He moreover adopts a supposed new species from Desfontaines, making three in all.

1. *E. tetraspermum*. Smooth-podded Tare. Linn. Sp. Pl. 1039. Curt. Lond. fasc. 1. t. 55. Engl. Bot. t. 1223. Stalks mostly two-flowered. Pods smooth, many-seeded.—A troublesome weed in cultivated land throughout Europe, flowering in June and July. Root annual, fibrous. Stem weak, climbing, branched, square, hairy. Leaflets numerous, alternate, linear-oblong, obtuse, hairy beneath, their common stalk ending in a branched tendril. Flower-stalks axillary, solitary, slender, as long as the leaves without their tendril, each bearing two (sometimes solitary,) little drooping flowers of a pale blue veined with dark purple. Calyx hairy. Pods half an inch long, pendulous, oblong or obovate, smooth. Seeds four; occasionally from five to seven in a variety found in Huntingdonshire and at Algiers, which we have in vain tried to make a distinct species.

2. *E. vicioides*. Vetch-like Tare. Desfont. Atlant. v. 2. 168. t. 198. Willd. Sp. Pl. v. 3. 1112.—Stalks many-flowered. Pods silky, two-seeded. Leaflets obovate, entire. Gathered by Desfontaines in hedges at Algiers. It appears to be very nearly related to the following, from which it

chiefly differs in being rather larger, and in having more rounded and not emarginate leaflets. Nothing however is more variable than the termination of the leaflets in *Vicia* and its allies. The pods are called silky, which is perhaps equally applicable to *E. hirsutum*. All things considered, we much doubt of the permanency of this species, which we, like Willdenow, adopt entirely from the excellent work of Desfontaines. We tolerate, but cannot approve the mixture of Greek and Latin in the name *vicioides*, which if the species should remain, ought to be made *viciaformis*.

3. *E. hirsutum*. Hairy-podded Tare. Linn. Sp. Pl. 1039. Curt. Lond. fasc. 1. t. 54. Engl. Bot. t. 970.—Stalks many-flowered. Pods hairy, two-seeded. Leaflets emarginate.—A pernicious weed in cornfields and pastures throughout Europe. It much resembles the first species, but the stem is usually smoother, the ends of the leaflets more abrupt and notched, the flowers and pods more numerous on each stalk. The most essential difference consists in the shorter, somewhat rhomboid, hairy pods, with only two seeds.—Mr. Curtis observes that he has “in wet seasons seen whole fields of corn overpowered and totally destroyed by this plant, which is stronger and more prolific than *E. tetraspermum*.” He does not, however, suggest any remedy. These weeds are too minute and inconspicuous when young to be eradicated, and when they have fixed their tendrils upon the crop, they can no longer be separated without “rooting up also the wheat with them.” S.

ERVUM *Oriente*. See SOPHORA.

ERVY, in *Geography*, a small town of France, in the department of the Aube, chief place of a canton in the district of Troyes, with a population of 1975 individuals. It is 9 miles S. of St. Florentin, and has some manufactures of linen-cloth. The canton contains 14 communes and 11,199 inhabitants; on a territorial extent of 222½ kilometres.

ERWASH, a river of England, which rises in the county of Nottingham, and almost in its whole course separates that county from Derbyshire, and falls into the Trent, 4 miles S. W. of Nottingham. See EREWASH.

ERWIFE, a town of Germany, in the circle of the Lower Rhine, and duchy of Westphalia; 5 miles S. of Lippstadt.

ERXLEBEN, JOHN CHRISTIAN POLYCARP, in *Biography*, was born in June, 1744, at Quedlingburg, where his father was dean of St. Nicholas's church. He studied medicine at Gottingen, where he took the degree of master of arts in 1765, and shortly after gave lectures on natural history and the veterinary science. Having published his introductory lectures, he undertook, at the expense of the Hanoverian government, a tour through France, Holland, Denmark, and a great part of Germany, in the course of which he acquired much practical knowledge in the veterinary art. On his return he lectured on the several sciences connected with natural history, and natural and experimental philosophy. In 1774, and the following years, he was elected a member of most of the learned societies on the continent. He died in August, 1777, when he had but just attained his thirty-third year. Erxleben published many works which were highly esteemed, among these are “Principles of Natural History;” “Principles of Natural Philosophy;” “An Introduction to the Veterinary Art.” Gen. Biog.

ERYANNOS, in *Ancient Geography*, a river of Asia Minor, in the Troade, which had its source in mount Ida.

ERYBIUM, a town of Greece, in the Doride, situated, according to Diodorus Siculus, at the foot of mount Parosus.

ERYCEIRA, FRANCIS DE MENESES, *Count of*, in *Biography*, born at Lisbon in 1614, was brought up to the use of arms, and obtained some important offices under government; but in the midst of his usual occupations he cultivated literature, and published a number of works, particularly histories of Tangier and Portugal; and the life of John I. king of Portugal.

ERYCEIRA, FRANCIS-XAVIER DE MENESES, was grandson of the preceding, and, like him, united a literary with an active and military life. He was born at Lisbon in 1672, and rose to eminence in the state. He was chosen member of various learned societies. From his ancestor he inherited a well chosen and extensive library, to which he made many great additions. He is said to have been the author of more than a hundred different works, of these, however, but few seem entitled to notice. The best known are, “Memoirs on the Value of the Monies of Portugal,” 4to. 1738; “Reflection on Academical Studies;” “Parallels on Illustrious Men and Women;” and “A Translation of the Henriade.” He died in the year 1743. Nouv. Dict. Hist.

ERYCINA, in *Mythology*, a surname given to Venus, from Erix, a mountain in Sicily, where she had a temple. Venus Erycina had also a temple at Rome, which was deemed very ancient even in the time of Thucydides. See ERIX.

ERYMANTHUS, in *Ancient Geography*, a mountain or forest of the Peloponnesus, in Arcadia, E. of a river of the same name, which had its source towards the north, on the confines of the Elide and of Arcadia, in mount Lampie. The wood of Erymanthus was full of boars, which made great desolation in the country. Hercules was employed to give chase to them, which he did with such success, that he slew with his own hands the largest of them. See HERCULES.—Also, a town of the Peloponnesus, in Arcadia, called *Phigia* and *Psophis*, according to Pausanias.

ERYMI, a people of Scythia, on this side of the Imaus. Ptolemy.

ERYMNÆ, a town of Asia Minor, in Lycia. Steph. Byz.—Also, a town of Greece, in Thessaly; placed by Pliny in Magnesia.

ERYNGIUM, in *Botany*, *εργυγιον* of Dioscorides, the derivation of which is unknown. Eryngo or Sea Holly. Linn. Gen. 127. Schreb. 177. Willd. Sp. Pl. v. 1. 1356. Mart. Mill. Dict. v. 2. Sm. Fl. Brit. 288. Juss. 226. Gærtn. t. 20. Class and order, *Pentandria Digynia*. Nat. Ord. *Umbellifera*.

Gen. Ch. *Common Receptacle* conical. *Flowers* all fertile, sessile, with scales between them. *Involucrum* of the whole receptacle of many leaves, flat, spreading beyond the flowers. *Cal.* Perianth superior, of five upright, acute leaves, sessile on the germen, shorter than the corolla. *Cor.* in the aggregate uniform, roundish. Petals five, equal, oblong, with a linear longitudinal striature, their points bent in, so as nearly to reach the base. *Stam.* Filaments five, capillary, straight, projecting far above the corolla; anthers oblong, versatile. *Pist.* Germen inferior, bristly; styles two, thread-shaped, a little spreading, somewhat shorter than the filaments; stigmas simple. *Peric.* Fruit ovate, separable perpendicularly into two parts. *Seeds* oblong, cylindrical; in some species remaining shut up in the crust of the pericarp, in others deciduous from it.

Ess. Ch. *Involucrum* of many leaves. *Flowers* in little dense heads. *Common receptacle* conical, scaly. *Seeds* bristly.

A most singular and very natural genus, having the habit and aspect of a thistle, the herbage rigid, thorny, either

either more or less tinged with vivid blue, or pallid and whitish; while the fructification is exactly that of an umbelliferous plant, though the inflorescence is capitate. Willdenow has eleven species, but they and their synonyms require a thorough investigation. Two are natives of Britain, viz. *E. maritimum*, Engl. Bot. t. 718, (in which plate we are sorry to remark that the petals are drawn reflexed instead of inflexed, an error that now escaped us.)—This is frequent on sandy sea shores throughout Europe, flowering in July and August. The long creeping perennial roots are aromatic and somewhat acrid; they are esteemed stimulant and restorative, and are sometimes sold candied. The herbage is glaucous variegated with a permanent blue. Leaves rounded, plaited, lobed, with spinous teeth. Flowers blue, in dense terminal heads, encompassed with a large leafy involucre. Scales of the receptacle three-cleft. The other British species is *E. campestris*, Engl. Bot. t. 57, found very rarely in England, though common on the continent. Its leaves are much more narrowly divided than the first, and pinnatifid. Flowers greenish-white, with narrow involucre leaves and undivided scales. This appears to be the true *eryngium* of Dioscorides.

Among the exotic kinds *E. amethystinum*, Linn. Sp. Pl. 337, a native of Styria; *E. alpinum*, *ibid.* Curt. Mag. t. 922, from the Swiss alps; and *E. planum*, Jacq. Austr. t. 391, are all hardy perennials, frequently cultivated for ornament. The *alpinum* is indeed peculiarly handsome, on account of its many-leaved, finely divided, blue involucre.

The following five species are not in Willdenow.

*E. cyanum*. Sm. Prod. Fl. Græc. Sibth. v. 1. 175. Fl. Græc. v. 3. t. 258. unpublished. "Radical leaves in five deep pinnatifid segments. Stem much branched and divaricated. Involucre of about five leaves."—Common in Greece and the islands of the Archipelago. The root is perennial. Stem 12 or 18 inches high, of a fine blue, as well as the involucre and foliage, many-flowered and divaricated. Leaves small, in linear, narrow, pinnatifid segments. Heads of flowers small, blue, with prominent, conspicuous, white anthers. This most resembles *E. triquetrum*, Vahl. Symb. v. 2. 46, in habit, but the flowers and involucre are very different.

*E. multifidum*, *ibid.* Fl. Græc. v. 3. t. 259.—"Leaves doubly pinnatifid, somewhat lyrate; radiated at the extremity. Stem corymbose. Involucre pinnatifid."—Gathered by Dr. Sibthorp in the Morea. Taller than the last, with a bright blue stem and flowers. The finely pinnatifid leaves give it the aspect of an *Echinops*. This is presumed to be *Eryngium creticum erectum, folio multifido, caule et ramis amethystinis*; Tourn. Cor. 23.

*E. parviflorum*, *ibid.* (*E. foliis laciniatis, capitulis florum exiguis et dense congestis*; Tourn. Cor. 23.) "Leaves bipinnatifid. Stem corymbose. Involucre three-cleft or simple, four times as long as the head." Of this no figure is extant, nor is it known where Dr. Sibthorp gathered the specimens found in his herbarium. The root is perennial. Herb whitish. Stem densely clothed with leaves, and bearing numerous flowers at the summit. Leaves twice or thrice pinnatifid, their segments narrow and divaricated. Heads of flowers very small, with large involucre, generally of five leaves, which are either undivided or three-cleft.

*E. purpuratum*. Leaves all pinnatifid, their lower part fringed with capillary teeth. Stem nearly simple, with few flowers. Involucre of about seven undivided leaves.—Gathered near Tangier by the late M. Broussonet and the Abbé Durand, who severally sent specimens to Dr. Smith. Root perennial. Stems a span high, round, furrowed, leafy,

scarcely branched, but bearing about three dark-blue heads of flowers, with very spinous calyces. Leaves all nearly alike, pinnatifid, with decurrent, sometimes lobed, segments; their lower part clasping the stem, pectinated, fringed with five long capillary teeth. Great part of the stem, and the upper side of each leaf of the involucre, are tinged with a rich deep blueish purple, hardly equalled in any other of the genus.

*E. carthamoides*. Leaves oblong, toothed, undivided, heart-shaped and clasping the stem at their base. Stem nearly simple, with few flowers. Involucre of several ovate leaves. Gathered by M. Broussonet in the neighbourhood of Algiers, flowering in June. Stem a foot high, strong, round, leafy, sometimes purplish, simple, except at the summit, where it bears from three to five large heads of blueish flowers, whose involucre consists of several large, ovate, purplish, spinous-toothed leaves, much resembling those of a *Carthamus*. The radical and stem-leaves are all simple, oblong, wavy, with large spinous teeth, veiny and pale-green.

ERYNGO, in the *Materia Medica*. The root of eryngium is attenuant and deobstruent, and is therefore esteemed a good hepatic, uterine, and nephritic. Its whole virtue, it is to be observed, consists in the external or cortical part. Their virtues, however, appear to be but weak; and they are now scarcely otherwise used than as made into a sweetmeat.

The London college directs it to be candied in the following manner: boil the roots till the rind will easily peel off; when peeled, slice them through the middle, and the pith being taken out, wash them three or four times in cold water; then for every pound of roots thus prepared, take two pounds of double-refined sugar; dissolve the sugar in water, set it on a fire, and as soon as it begins to boil, put in the roots, and continue the boiling till they become soft.

These candied roots are an ingredient in artificial asses milk, which is thus made: take of candied eryngo root one ounce, pearl barley half an ounce, liquorice root three drams; boil them in two pints of water to one pint, to which add a pint of new milk from the cow; boil them gently together, then strain the liquor for use, of which half a pint should be drunk three times a day.

ERYNNIS, *q. d. epis vs, contentio mentis*, or because, as Paulianus remarks, *ἐπύνην* signifies to fall into a fury, or *Furious*, a name given to Ceres by the Sicilians.

ERYSIBE, in *Botany*, *ερυσίβη, rust, or the mildew of corn*, from its rusty panicle. Roxb. Pl. Coromand. v. 2. 31. Class and order, *Pentandria Monogynia*. Nat. Ord. *Sapoteæ*, Juss.

Gen. Ch. Cal. Perianth in five deep, roundish, concave, permanent segments. Cor. of one petal, salver-shaped, the length of the calyx; tube cylindrical, pervious; limb the length of the tube, in 10 roundish segments, spreading. Stam. Filaments five, very short, inserted into the lower part of the tube; anthers erect, ovate, shorter than the tube. Pist. Germen superior, ovate; style none; stigma five-lobed. Peric. Berry oval, of one cell. Seed solitary, large.

Eff. Ch. Corolla salver-shaped; limb in ten equal segments. Style none. Stigma five-cleft. Berry superior, with one seed.

*E. paniculata*. Roxb. Coromand. t. 159. The only known species, a native of the mountain forests of India, from whence Dr. Roxburgh sent us specimens in 1789. A very large climbing shrub. Branches alternate, leafy, round, clothed when young with copious rusty down. Leaves alternate, three- or four inches long, spreading and

defflexed, elliptic-oblong, pointed, entire, velvety; smooth and shining above; paler and opaque beneath. *Footstalks* half an inch long, angular, rusty. *Stipules* none. *Panicles* many-flowered, terminal, erect, much branched, about a span long, their stalks, small oblong scattered bractæas, and the calyx, all densely clothed with rusty down. Tube of the *corolla* greenish; limb yellow, about three lines in diameter. *Berry* the size of a small cherry, black, pulpy, containing one large seed.

Of the uses or qualities of this plant or its fruit we have no account. From its botanical affinity to *Chrysophyllum*, *Achras*, &c. it may certainly be eaten with safety. The flowers are not inelegant.

ERYSIMA, in *Ancient Geography*, a town of Asia, in Cappadocia.

ERYSIMUM, in *Botany*, ερυσιμον of Theophrastus and Dioscorides, about the etymology of which there is much controversy among the learned, but, as often happens in such controversies, nothing satisfactory. Hedge-mustard. Linn. Gen. 339. Schreb. 442. Willd. Sp. Pl. v. 3. 509. Mart. Mill. Dict. v. 2. Sm. Fl. Brit. 706. Juss. 239. Tournef. t. 111. Gærtn. t. 143. Class and order, *Tetradynamia Siliquosa*. Nat. Ord. *Siliquosa*, Linn. *Crucifera*, Juss.

Gen. Ch. *Cal.* Perianth of four ovate-oblong, coloured, parallel, cohering, deciduous leaves. *Cor.* cruciform, of four oblong, flat, very obtuse petals, whose claws are the length of the calyx and erect. Nectary a gland betwixt each of the shorter filaments and the germen. *Stam.* Filaments six, the length of the calyx; of which two opposite ones are shorter than the rest; anthers simple. *Pistl.* Germen superior, linear, square, the length of the stamens; style very short; stigma small, capitate, permanent. *Peric.* Pod long, linear, straight, exactly square, of two cells and two valves. *Seeds* numerous, small, roundish.

Eff. Ch. Pod straight, columnar, exactly square. Calyx-leaves cohering. Stigma capitate.

Willdenow has 14 species, of which five are British.

1. *E. officinale*. Linn. Sp. Pl. 922. Curt. Lond. fasc. 5. t. 50. Engl. Bot. t. 735. "Pods close-pressed to the main stalk. Leaves runcinate." Common in waste ground and about hedges. This is usually taken for the ερυσιμον of Dioscorides, whose description, more full than usual with that writer, is very applicable to it. Dr. Sibthorp, however, decidedly considered *Sisymbrium polyceratium* as the plant Dioscorides meant, and this, perhaps, will be found to accord still better with his description, which compares the horn-like pods to fœnugreek. See its figure in Matthioli, Ed. Valgr. fol. v. 1. 524. The ερυσιμον of Theophrastus is supposed to be a still different plant, as he reckons it among the various kinds of grain.

In this and similar cases, therefore, though the Linnæan generic name is adopted from ancient writers, it does not follow that their plant is of the same genus, which matter is frequently impossible to be ascertained. It is sufficient that such names are established by common consent amongst systematical botanists, from whom they acquire a new stamp of authority; nor ought they to be changed, whatever new light may be thrown upon them by future commentators. We study by the arrangements of Linnæus or Jussieu, not by those of Theophrastus or Dioscorides. It is only in case any species requires to be separated from an established genus, that we are glad to recur to its ancient appellation for a generic name; as in the cases of *Cyamus*, Sm. Exot. Bot. v. 1. 59. t. 31, 32 (see *CYAMUS*); and *Nuphar*, Prod. Fl. Græc. v. 1. 361.

2. *E. Barbara*. Linn. Sp. Pl. 922. Engl. Bot. t. 443.

"Lower leaves lyrate; their terminal lobe rounded: upper ones obovate, toothed."—Common in waste ground, either dry or wet, flowering most in the spring. Its numerous flowers of a full yellow, often seen double in gardens, and its dark shining broad leaves easily distinguish it. The whole plant has a nauseous, bitter, slimy flavour.

3. *E. praecox*. Sm. Fl. Brit. 707. Engl. Bot. t. 1129. "Lower leaves lyrate: upper ones pinnatifid, their segments linear, oblong, and entire."—Found in Devonshire by the Rev. Dr. Beeke. The narrow lobes of the stem-leaves, smaller flowers, and much longer pods, distinguish this from the last, with which we believe Linnæus confounded it. The distinction is highly important, as we are convinced the present is the very same with the American Cress, as it is called, or rather Winter Cress, of the gardens, an agreeable and wholesome pungent herb for fallads, &c.

4. *E. Alliaria*. Linn. Sp. Pl. 922. Curt. Lond. fasc. 2. t. 48. Engl. Bot. t. 796. "Leaves heart-shaped."—Common under hedges in the spring, and knowna by its broad toothed leaves, white flowers, and strong scent of garlick when bruised.

5. *E. cheiranthoides*. Linn. Sp. Pl. 923. Engl. Bot. t. 942. Jacq. Austr. t. 23.—"Leaves lanceolate, slightly toothed. Pods erect. Flower-stalks when in fruit spreading."—Not rare in Oser-grounds, Turnip-fields, and other cultivated ground, where the soil is gravelly or sandy, flowering in July. This resembles the yellow stock or wall-flower in habit and leaves, but the small flowers and square pods at once distinguish it.

The exotic species are not quite so well ascertained as ours. Ehrhart and Roth have taken pains to elucidate them, and the result is given by Willdenow. We know not that any of them is worthy of the attention of the cultivator except for botanical curiosity.—They are all either annual or biennial, perfectly hardy in our climate, and bear narrow lanceolate leaves, with small yellow flowers. As weeds their copious seeds render them rather troublesome.

ERYSIPELAS, from ερυσσ, to draw, and πηλας, near, from the disposition of the affection to draw the adjacent parts into the same state; or from ερυθρος, red, and μελας, black, a dark red.) The generality of surgical authors have considered erysipelas as a species of inflammation, and every reflection induces us to entertain the same opinion, notwithstanding the opposite sentiment of one of the lecturers on surgery in this metropolis. The immortal Celsus has observed: "notæ verò inflammationis sunt quatuor; rubor, et tumor, cum calore et dolore," lib. 3. cap. 10. According to this definition, erysipelas is certainly an inflammation, although the degree of swelling is not so great, nor the pain exactly of the same kind, as in cases of phlegmon, or common inflammation.

With many distinguished surgical authors, we regard erysipelas as a particular kind of inflammation, most frequently affecting the small vessels on the surface of the body. It is, as Mr. Hunter describes, more commonly a cutaneous inflammation, than one situated in deeper parts; although it is probable, that, in some constitutions, every inflammation, wherever it exists, will be of this kind. However, there can be no doubt of the fact laid down by this accurate observer, viz. that the skin appears to be the most susceptible of erysipelas, because this affection will spread over a prodigious extent of the surface of the body, while (at least, in common instances) the cellular membrane underneath remains free from disorder. (See Hunter on Inflammation, p. 270.)

Mr. Hunter taught surgeons, that one of the uses of the adhesions,

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adhesions, which form in cases of common inflammation, is to circumscribe and bound the matter, in the event of suppuration taking place. Now, in erysipelas, the extravasation in the place affected is not so considerable as in phlegmon, nor is it of that kind, which produces adhesions among the inflamed parts. Indeed, since erysipelas seldom ends in suppuration, such adhesions, according to Mr. Hunter's view of the subject, would in general be unnecessary. Perhaps, also, the circumstance of there being no adhesions in erysipelatous cases, may account for the terrible diffusion of mischief, which always happens, when abscesses do occasionally take place. Then, we know, that the matter makes its way extensively through the cellular substance, in every direction under the skin, under fascia, and between the muscles, producing, wherever it goes, what has been often named a gangrenous suppuration. When erysipelas is of an unmixed kind, it has not the dark red colour which common inflammations have, but a lighter red, with a yellow tinge, which is particularly observable towards the termination of the disorder. The swelling which occurs is unattended with any remarkable induration, and forms a very inconsiderable prominence. The skin of the inflamed part has a shining appearance, and, on being touched with the finger, turns white at the spot where the pressure is made; but the bright red colour immediately afterwards returns. The pain is usually of a burning, shooting description, and the patient frequently complains of a sort of itching, which is found to be particularly annoying. The swelling, which happens in cases of erysipelas, is not only not so hard and elevated as that which arises in examples of phlegmonous inflammation, it is at the same time not so clearly circumscribed.

Another remarkable feature of erysipelas, is the manner in which this inflammation often changes its situation, by getting well on one side, while it is spreading in some other direction. The great celerity with which the affection spreads, and the large surface which it in a very little while covers, may also be set down among its most striking peculiarities.

When the affection is intimately dependent on the state of the constitution, we very often see all the local symptoms recede in one place, and the disease make its attack in some other part of the body. Such instances are not unfrequently mentioned by writers as *metastases*, just as if it were a real fact, that, when the erysipelatous symptoms get well on one leg, and the other leg becomes affected in a similar way, these events happen, in consequence of the first identical disease actually moving from one limb to the other. From this absurd doctrine originates all the cant about the danger of using such applications as are likely to repel the inflammation. The truth is, that the second attack of the erysipelas is not at all connected with the termination of the first; but arises from some different, and probably inexplicable cause, just as encysted tumours will often form, one after another, in various parts of the body, as regularly as they are cut out. In this latter instance, no one is absurd enough even to suspect that the growth of one tumour is the effect of a previous one being cured.

In true erysipelas, there is no throbbing of the part affected, as in cases of phlegmon; and when erysipelatous inflammation runs along the skin, the affection has a determinate edge, and does not lose itself gradually and insensibly in the surrounding parts, as common inflammation does.

The alteration which the skin undergoes in erysipelas consists in its feeling at the part affected less pliable than in the natural state, and a little thickened.

Such are the ordinary local symptoms of erysipelas.

They are subject, however, to some variety, depending on the mildness or violence of the attack, and on the circumstance of the disorder being either simple, or complicated with another affection; for instance, œdema, phlegmon, &c.

With respect to violence, erysipelas may be very properly divided into three degrees. In the first, or mildest form of the complaint, the erysipelas makes its appearance, without any preceding illness, or with only a slight indisposition of short duration, and consisting of lassitude, disturbed sleep, loss of appetite, &c. These complaints very soon go off, when the erysipelas comes out, which happens in about a couple of days. For two days more the local symptoms remain the same, and then the erysipelas turns pale and yellow, gradually disappearing altogether, with a detachment of the cuticle. During the whole course of the disorder there is no fever of any consequence; but a little while before the redness occurs the pulse is sometimes rather disturbed.

In the second, or more severe degree of the disorder, the patient is troubled, about two days before the erysipelas makes its appearance, with an unusual prostration of strength, heaviness in all his limbs, head-ach, loss of appetite, nausea, and even actual vomiting, complaints in the stomach, &c. Besides these inconveniences, the patient is affected with a fever, and all its usual symptoms. After a couple of days, commonly on the third day from the commencement of all indisposition, the erysipelas comes out, attended with a gentle sweat, and a moderate increase in the secretion of urine, after which circumstances the fever, with all its attendant symptoms, goes off. The rest of the progress of the case is similar to what we have related, as happening in the first, or mildest attack of erysipelas.

In the third, or most violent degree of the disorder, particularly in those cases in which erysipelas makes its attack on the face, the patient is affected with severe febrile symptoms, head-ach, loss of sleep, delirium, sickness, &c. These complaints do not diminish, as in the milder cases of erysipelas, when the local redness, heat, &c. take place on the third day; but continue with unabated vehemence, until the erysipelas itself subsides. The last desirable event commonly happens, according to Richter, on the eleventh day, accompanied with an increase in the secretions from the skin and kidneys.

The most dangerous cases of erysipelas are those in which the face is affected. Of this form of the disorder, the celebrated Cullen has left us a matchless description, which we think is highly deserving of insertion in this Cyclopædia. The erysipelas of the face, (says this interesting author,) comes on with a cold shivering, and other symptoms of pyrexia. The hot stage of this is frequently attended with a confusion of head and some degree of delirium; and almost always with drowsiness, or perhaps coma. The pulse is always frequent, and commonly full and hard.

When these symptoms have continued for one, two, or at most three days, there appears on some part of the face a redness, such as that of erythema. This redness at first is of no great extent; but, gradually spreads from the part it first occupied, to other parts of the face, commonly till it has affected the whole; and frequently from the face it spreads over the hairy scalp, or descends on some part of the neck. As the redness spreads it commonly disappears, or, at least decreases in the parts it had before occupied. All the parts upon which the redness appears are at the same time affected with some swelling, which continues for some time after the redness has abated. The whole face becomes considerably turgid; and the eye-lids are often so much swelled, as entirely to shut up the eyes.

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To continue Dr. Cullen's account: when the redness and swelling have proceeded for some time, there commonly arise, sooner or later, blisters of a larger or smaller size on several parts of the face; these contain a thin yellowish, or almost a colourless liquor, which sooner or later runs out. The surface of the skin in the blistered places sometimes becomes livid and blackish, but this livor seldom goes deeper than the surface, or discovers any degree of gangrene affecting the skin. On the parts of the face not affected with blisters the cuticle suffers, towards the end of the disease, a considerable desquamation.

Sometimes the tumours of the eye-lids end in a supuration.

The inflammation coming upon the face does not produce any remission of the fever which had before prevailed; and sometimes the fever increases with the increasing and spreading inflammation.

The inflammation usually continues for eight or ten days; and, for the same time, the fever and symptoms attending it also continue.

In the progress of the inflammation, the delirium and coma attending it sometimes go on increasing, and the patient dies apoplectic, on the seventh, ninth, or eleventh day of the disease. In such cases, it has been commonly supposed that the disease is translated from the external to the internal parts. But, Dr. Cullen observes, that he never met with any instance in which it did not appear to him, that the affection of the brain was merely a communication of the external affection, as this continued increasing at the same time with the internal.

When the fatal event does not take place, the inflammation, after having affected a part, commonly the whole of the face, and, perhaps, the other external parts of the head, ceases. With the inflammation the fever also ceases; and, (says Cullen,) without any evident crisis, the patient returns to his ordinary state of health.

The same distinguished writer represents the disease as being not commonly contagious; but he conceived it possible that it might sometimes be communicated from one person to another; and, he adds, that persons who have once laboured under the disorder are liable to returns of it.

According to Cullen, the event of the disease may be foreseen from the state of the symptoms which denote more or less affection of the brain. If neither delirium nor coma comes on, the disease is seldom attended with any danger; but when these symptoms appear early in the disease, and are in a considerable degree, the utmost danger is to be apprehended.

We have already remarked that, in cases of erysipelas, suppuration does not frequently happen; but that when it does, owing to the matter not being confined by the adhesive inflammation, very bad consequences follow. Wherever the matter spreads, it occasions under the skin an extensive sloughing of the fasciæ, tendons, and cellular substance, all which kind of mischief may take place; while the skin itself, which is very vascular and highly organized, remains unimpaired in its texture. This combination of suppuration and mortification is more likely to happen when the erysipelatous inflammation extends to a greater depth than common, so as to affect the cellular membrane. In this state, as Mr. Hunter has well described, air, matter, and sloughs, are all produced together under the skin, and, on handling the part, a strange feel is communicated, neither like that of a fluctuation, or a crepitation. Mr. John Pearson very whimsically, we will not say unaptly, compares the sensation with that excited by a quagmire or morass. Frequently, the practitioner may observe in some opening, made either by ulcera-

tion or the lancet, a small black sloughy point, and, on taking hold of it with a pair of forceps, and drawing it out, he finds, to his great surprise, that a whole mortified tendon, of considerable length, follows his instrument.

Erysipelas is to be met with more frequently in summer than winter, and more commonly in hospitals than other places. Wounds of the head, oftener than any other kind of accident, give rise to the disorder.

Erysipelas has sometimes been observed on the skin of new-born infants. Several instances of this kind are mentioned in the Medical Communications, as having occurred in the British Lying-in-Hospital. In one of these examples, the child was born with its whole face swelled and inflamed, the left side being affected with a true erysipelas. There was also an inflammation on the legs, feet, and left hand. On each tibia, there appeared an oblong slough, of a dark brown colour, almost livid; the one on the left leg was exceedingly large. The cure was attempted by employing embrocations, emollient poultices, and fomentations, and applying camphorated spirit of wine. This child appears to have swallowed the decoction of bark with great ease, as it took four ounces of it every day from the very time of birth. In three days the swelling of the face and other parts had considerably subsided; but, on the third day, a vesication began to form on the left cheek, and another just above the eye-brow, on the same side. These vesications increased in number and size, especially on the legs, where they extended over the whole limb. Some confectio cardiaca was added to the decoction of bark, and pledgets, dipped in oil of turpentine, were put on all the parts affected, previously to the application of the poultice. The vesications began to break on the sixth day, and a sanies to issue from them; yellow sloughs also now made their appearance in different parts. The child seemed much debilitated, and, for the last three or four days, had taken eight ounces of the decoction of bark, with one dram of the confectio cardiaca every twenty-four hours. The pledgets, applied to the sores, were dipped in a digestive ointment, with oil of turpentine, and some cataplasm e cymino. Under this mode of treatment, the sloughs were soon detached, and the child recovered, though not without the loss of the little finger, two joints of the ring finger, and one of the middle one.

The distemper, which we have just been describing, for some time proved extremely fatal, none of the infants recovering who were attacked. However, bark is stated to have acted quite as a specific remedy for the disease, as soon as it was tried, and almost all the children are said to have got well who took this medicine. Mortification always took place in such subjects as died; and the danger was regularly observed to be the greatest in the instances in which the genitals were the parts first attacked. The disease was also noticed to affect the children of weakly women, and of such as were addicted to drinking spirits.

To return, however, to our account of the common forms of erysipelas, we have to apprise the reader, that the term "St. Anthony's fire," which is so frequently mentioned by all sorts of persons, is strictly applied by medical writers and practitioners to that species of the affection in which vesicles arise upon the surface of the skin; while other instances, not accompanied with vesications, are named *simple erysipelas*.

The division of the subject, however, cannot be properly comprehended under these two varieties; and the generality of authors have found it necessary to observe other distinctions.

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Mr. Pearson, in his Principles of Surgery, has noticed the following species of the complaint :

1. The acute erysipelas.
2. The œdematose erysipelas.
3. The malignant, or gangrenous erysipelas.

Each of these species may be an idiopathic, or symptomatic disease.

Mr. Pearson remarks, that the acute erysipelas is most commonly seen in those of a sanguine and choleric temperament ; it is generally sudden in its attack, and usually affects the face. Febrile symptoms are often present immediately after the accession of the disease ; but they gradually diminish as the erysipelas becomes more distinctly formed. Considerable heat, and great uneasiness, take place in the part affected ; the skin is also of a brighter scarlet colour than in the other species. If pustules appear, they are distinct ; but sometimes there are no vesications on the surface.

Suppuration very rarely occurs in this kind of erysipelas, and the violence of the disease commonly subsides in three or four days ; the part then grows yellowish, and throws off furfuraceous scales. The disease terminates about the tenth day. A tenderness of the hairy scalp will often continue for a considerable time after the disease has disappeared.

The acute erysipelas, as we have already observed, is sometimes an idiopathic affection ; frequently it is symptomatic, or, in other words, the consequence of a wound, especially one of the head. Persons who have once been attacked with the acute erysipelas, in a spontaneous manner, are particularly liable to suffer again from future attacks of the same disorder.

Mr. Pearson states, that the œdematose erysipelas is not, in general, so sudden in its attack, nor so severe on its accession, as the acute erysipelas. The disease increases gradually, is more diffused, and is attended with less burning pain. If febrile symptoms should arise, they never run high, nor are they of long duration ; most commonly the strength is depressed, attended with a soft, frequent, perhaps, irregular pulse. In this species of erysipelas no constitutional relief is derived from the appearance of the local affection : on the contrary, the danger increases with the progress of the external disease.

When the face is the seat of the œdematose erysipelas the whole countenance has a bloated appearance. The red colour of the skin is mingled with yellow or brown, and the complaint is attended with shiverings, vomiting, and more or less disturbance of the functions of the brain. Mr. Pearson further remarks, that the vesications are often small and numerous, and, that when they have been exposed for a few days to the air, the countenance becomes covered with a dark-coloured crust, very much resembling the appearance which arises in the confluent small-pox. Though the face is very much swelled, it is not firm to the touch, and easily yields to pressure.

The œdematose erysipelas is deemed highly dangerous. Patients often die, in a delirious or comatose state, about the seventh day, sometimes a little later.

It is common to see many people afflicted with this species of erysipelas about the same time. Mr. Pearson informs us, that, in hospitals, he has seen several persons successively attacked with the complaint in the same ward. Some conjectures have been entertained of the disorder being contagious.

All ages and constitutions may be affected with the œdematose erysipelas. However, subjects weakened by age, or intemperance, are most frequently attacked. Dropsical

patients, children, and new-born infants, are also seen affected with the complaint.

According to Mr. Pearson, the œdematose erysipelas, when symptomatic, is much less dangerous than when idiopathic ; but, says this author, whenever the face is considerably affected, the disease is always to be regarded as a serious one, whatever be the remote cause. On the limbs it is seldom dangerous, or very afflicting, unless treated in an improper way. Mr. Pearson mentions his having seen the œdematose erysipelas make its first appearance upon the face, and, by a gradual and regular progression, proceed downward to the extremities, successively appearing upon an inferior portion of the body, as it disappeared from a superior part. Each renewed accession of the complaint was less and less severe, as it receded to a greater distance from the part that was primarily affected.

The malignant, or gangrenous erysipelas, makes its first appearance somewhat like the œdematose form of the disorder. Its progress, however, is much quicker. Phlyctenæ, with a livid base, soon occur on the skin, together with gangrenous symptoms. The disease, at a very early period, becomes attended with a state of the constitution, resembling that which exists in putrid fevers.

The gangrenous erysipelas mostly occurs on the face, neck, breast, and shoulders : the danger of the disease depends very much on the state of the constitution.

When an erysipelatos inflammation, particularly one of the legs has been cured, a degree of œdema will frequently continue about the lower part of the limb for some time afterwards.

Erysipelatos inflammation differs from phlegmon in the following respects. The swelling is less prominent ; and is never distinctly circumscribed. The skin often has the appearance of being scorched, or burnt. The redness is quite circumscribed, has a very determinate edge, is frequently tinged with yellow, and, on being touched with the end of the finger, a white spot is produced for a short time in the place where the pressure was made. The pain is not of the lancinating, throbbing kind, which attends phlegmonous inflammation ; but is such as causes a sensation of a great heat and burning in the part, together with a violent degree of itching. The part affected does not present the feel of, what surgeons understand by, tension ; but only seems to the touch as if the skin were a little thickened. Except in the acute erysipelas, there is no hardness of the pulse, as in cases of phlegmon, and instead of being attended, as the latter affection, with rather an increase of strength, erysipelas is almost always accompanied with more or less debility.

With respect to the causes of erysipelas our knowledge is very imperfect, and every observation on this subject must be received with doubt. We do not mean to state, that the remote causes are not very often sufficiently obvious. We frequently have occasion to remark, in the practice of surgery, that certain punctured wounds, and injuries of the external parts of the head give rise to erysipelas. Indeed, we may state, as a general remark, that the same class of irritations, termed *remote causes*, which in one constitution would occasion phlegmonous inflammation, in another would excite erysipelas. What is far more difficult of investigation, is the cause why erysipelas should take place rather than common inflammation ; in other words, the exact particularity, to which the origin of erysipelatos inflammation is to be ascribed, is involved in much more obscurity. Sometimes even the remote cause cannot be discovered, the affection having the appearance of originating in a spontaneous manner.

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It was one of the ancient doctrines, established by Galen, and maintained down to the present time, that what is understood by a bilious habit is particularly subject to erysipelatous inflammation. Many parts of the writings of the celebrated Pott, the experienced Richter, and other noted modern writers, evince their belief in this opinion.

Weak and irritable constitutions appear to us to be most subject to erysipelas; while strong, plethoric persons most frequently undergo common phlegmonous inflammation. We think, that there is every reason to believe, that, in general, erysipelas is intimately dependant on the state of the constitution, or on some peculiarity of temperament. This opinion is somewhat confirmed by the fact, that while persons, who lead drunken, intemperate lives, are particularly often afflicted with erysipelatous inflammation, in consequence of local injuries, other people, who lead more regular lives, generally have phlegmonous inflammation after similar injuries.

It must be admitted, however, that erysipelas occasionally makes its appearance in constitutions with which we can find no evident fault. Indeed, Hunter seems to have considerable reason for his inference, that the affection may, in some instances, be altogether independent of constitutional causes, since it is the common course of the disease to be actually getting well on one side as fast as it is spreading on another.

If we can sometimes assign particular circumstances, which operate as causes conducive to erysipelas, it is all that we can hope to do. To trace the proximate cause in every example which presents itself, is far beyond our pretensions; neither do we believe that it is to be done by the powers of human research. We might adopt the language of Cullen, and talk of erysipelas depending "on a matter generated within the body, and thrown out, in consequence of fever, upon the surface of the body." We might also join Mr. Pearson in representing erysipelas as being sometimes the "critical termination of another disease, such as obstructed menstruation, quartan ague, suppressed suppuration, spasmodic and convulsive diseases." However, we should shew just as much devotion for truth, were we to offer any other wild, vague suppositions, unsupported by rational evidence.

Less aspiring in our attempts, we shall only aim at pointing out circumstances which seem to act as causes, conducive to the disorder, in some instances. If many women of temperate lives, and young children, are occasionally affected with erysipelas, as they undoubtedly are, the fact only proves, that there are other causes besides intemperance which may be concerned in giving rise to the complaint. The sources of the disease must, we believe, on some occasions, be regarded as among the mysterious and inaccessible secrets of nature. When drunkenness and other kinds of intemperance are assigned as causes conducive to erysipelas, it is not meant that they are exclusively so. There are, probably, hundreds of other causes in existence, though we may not be able to detect them.

With regard to women of temperate regular lives, and to children being occasionally affected with erysipelatous inflammation, the fact cannot be called in question. But, still, no experienced man will contend that such subjects are attacked with erysipelas, on meeting with local injuries, half so frequently as persons with constitutions impaired by any kind of intemperance, habits, or modes of life.

Richter and some other writers, have described erysipelas as depending very much on a suppressed state of the perspiration; but we are inclined to think that they have ascribed the importance of a cause to a mere effect of the fever, with which erysipelas is connected.

*Treatment of the acute, or phlegmonous erysipelas.*—This species of the disease being commonly attended with a full, and frequently a hard pulse; the blood drawn shewing upon its surface the buffy coat to be seen in all inflammatory complaints; and lastly, the swelling of the eyelids, frequently ending in suppuration; there can be no doubt, that the affection should be treated very much in the same manner as phlegmonous inflammation. Blood-letting, cooling purgatives, and every part of the antiphlogistic regimen, are advised by Cullen, who affirms, that his experience had confirmed the fitness of this method of cure.

The evacuations of blood-letting and purging are to be employed, more or less, according to the urgency of the symptoms, particularly the febrile ones, and those which mark an affection of the brain.

Although Mr. Pearson mentions general and topical bleeding as being indicated in the treatment of the acute erysipelas, yet he observes, that cases very rarely occur in large towns where bleeding is at all admissible, and a repetition of the operation can very seldom be proper.

Professor Richter strongly praises the good effect of emetics on erysipelas; but some other writers, probably in a strain of ignorance, or prejudice, represent such medicines as having sometimes occasioned fatal consequences.

Another indication is to promote a gentle degree of perspiration. For this purpose, we may exhibit small doses of the antimonium tartarifatam, or the pulvis ipecacuanha comp., æther vitriolicum; saline draughts with volatile alkali, &c.

Opium and camphor are also proper remedies for allaying irritation.

Whoever has been in the habit of consulting the writings of several celebrated medical authors, will perceive that they place great reliance on bark, as a medicine tending very powerfully to check and cure erysipelatous inflammations. When we mention Mr. John Hunter among such authors, our readers will be inclined, perhaps, to suspect that there must be some foundation for the repute into which this medicine has risen for the complaints under consideration. However, we must confess our own belief, that bark gained credit for its good effects on erysipelas entirely in consequence of the general enthusiasm which once depicted it as a cure for almost every disease of the human frame. The sentiment is corroborated, if not confirmed, by the fact, that the best modern practitioners seem now to consider bark no longer of eminent service in cases of acute erysipelas.

With respect to local applications, in these instances, several kinds have been used by different practitioners. Cold astringent lotions, oily substances, rubefacients, farinaceous, or earthy powders, and emollient poultices, have all been tried. As far as our experience extends, the lotio aquæ lithargyri acetatis is as good an application as can be made to a part affected with the acute species of erysipelas. However, it becomes us to apprise the reader, that the majority of medical writers bestow the greatest praise on the employment of dry mealy powders, such as flour, starch, &c. for topical remedies, with which the inflamed part is to be covered.

Mr. Pearson, strangely enough, speaks in favour of rubefacients, as if the skin were not already reddened enough by the disease; but reserves his highest recommendations for mild warm poultices. Let the surgeon, however, consider the ill consequences and terrible mischief which always occur when suppuration supervenes, and let him beware of the injudicious plan of promoting the latter event.

*Treatment of the adematose erysipelas.*—In this case topical bleeding may be practised; but venesection is hardly

ever allowable. The bowels should be kept open with saline purgatives of the mildest description, and a gentle perspiration ought to be excited, by means of small doses of tartarised antimony, the pulvis ipecacuanha comp., &c. For the purpose of appeasing pain and irritation, the practitioner may prescribe camphor, opium, æther, &c.

When the patient's constitution is in a debilitated condition, tonics are indicated, together with the most nourishing food. Bark, wine, porter, brandy, the confectio aromatica, may now be found of the utmost service.

*Treatment of the malignant or gangrenous erysipelas.*—Little need be said here on this subject, as the mode of treatment is the same as that of mortification in general. See **GANGRENE**.

The grand objects are; to support the patient's strength; to cover the parts affected with emollient poultices; to foment them two or three times a day with a decoction of poppy-heads; to make depending openings for the escape of the matter and sloughs; and remove the dead parts, as soon as it can be done without occasioning the least irritation and pain.

We have frequently seen the gangrenous mischief so extensive in these cases, that amputation of the limb was the only means of saving the patient from destruction. See Richter's *Anfangsgründe der Wundarzneykunst*. Band i. Von der Rose. Pearson's *Principles of Surgery*. Cullen's *First Lines of the Practice of Physic*. Cooper's *First Lines of the Practice of Surgery*.

**ERYSIPHE**, in *Agriculture*, a term applied by some to that vegetable disease generally known by the name of mildew. See **MILDEW**.

**ERYSTHIA**, in *Ancient Geography*, a town of the island of Cyprus. Steph. Byz.

**ERYTHEIA**, an island of Iberia, in the ocean. According to Strabo, it was separated from the continent by a large strait of a stadium, or, according to Pliny, of 100 paces. It was near Gades. Its name was derived from the Phœnicians, who, having inhabited the banks of the Erythrean sea, came to settle here. It was also called *Aprodisias*, or the isle of Venus, and the isle of Juno. See **GADES**.

**ERYTHEMA**, in *Surgery*, (from *ερυθρο*, red.) The celebrated Cullen distinguished two classes of erysipelatous inflammations. When the disease was an affection of the skin alone, and very little of the whole system, or when the affection of the system was only symptomatic of the external inflammation, he called the disease *erythema*; but when the external inflammation was an exanthema, and symptomatic of an affection of the whole system, he named the disease *erysipelas*, which see.

“An Erythema, Rose, or St. Anthony's Fire, (says Dr. Cullen) is an inflammatory affection of the skin, with hardly any evident swelling; of a mixed, and not very bright red colour, readily disappearing upon pressure, but quickly returning again; the redness of no regular circumscription, but spreading unequally, and continuing almost constantly to spread upon the neighbouring part; with a pain like to that from burning; producing blisters, sometimes of a small, sometimes of a larger size, and always ending in a desquamation of the scarf-skin, sometimes in gangrene.”

We need not enlarge on the subject of erythema, in the sense of an erysipelas not originating from a constitutional affection, as every useful information, concerning erysipelatous inflammations in general, is to be found in the article **ERYSIPELAS**.

The chief object which we have in view in the present part of this work, is to describe a particular affection of the

skin, named, in consequence of its being occasioned by the use of mercury, the *mercurial erythema*, or *eczema*.

It was perhaps, for the first time, distinctly noticed and described by Mr. Benjamin Bell in his *Treatise on the Venereal Disease*. “It is not an uncommon effect of mercury (says this author) to excite an eruption upon the surface of the body. In some, this appears as a milium rash, somewhat resembling measles; while in others it is considerably elevated, and seems to be produced by a serous effusion between the cutis and scarf-skin. In some the eruption is partial, being confined to particular spots; while in others it prevails generally over the whole body.

“This eruption, or efflorescence, is not attended with pain; but the heat and itchiness which accompany it are, in some instances, so distressful, that it keeps the patient at all times very uneasy, and deprives him entirely of rest.

“The remedies, (observes Mr. B. Bell) which I have found to answer the best, are the internal use of opiates, conjoined with the application of flour or starch-powder to the parts affected. The skin is kept sufficiently cool and easy by one or the other of these powders being from time to time freely applied to the eruption; and, by a proper exhibition of opiates we secure rest during the night. In some instances, however, we are obliged to avoid the use of opiates; for although they may answer the purpose of procuring sleep, they tend evidently to increase the heat and itchiness of the eruption. We find, indeed, that, in some constitutions, opium excites an uneasy itchy sensation over the whole body, even where an eruption has previously taken place: and it is, perhaps, with such patients only, that it cannot be employed in the treatment of this eruption.

“The eruption to which I allude, (adds Mr. Bell,) appears to arise entirely from the effect of mercury upon the system; but it does not seem to depend upon any particular preparation of the remedy. It takes place indiscriminately from all of them; and not more readily from unction than from those preparations that are used internally.” See a *Treatise on Gonorrhœa Virulenta and Lues Venerea*; by B. Bell, vol. ii. p. 228.

Since this gentleman published the foregoing work, the mercurial erythema has excited considerable attention, and several writers, viz. Drs. Moriarty, M<sup>c</sup>Mullin, and Spens, and Messrs. Alley and Pearson, have endeavoured to render our knowledge of the subject more extensive.

Dr. M<sup>c</sup>Mullin judiciously observes, that eruptions of various kinds are very common symptoms of syphilis, but a very unusual effect of mercury. Hence, until the real nature of the mercurial erythema was ascertained, whenever the affection occurred in patients undergoing a mercurial course for syphilitic complaints, it was naturally enough considered as an anomalous form of lues venerea. The mercury was consequently pushed to a greater extent, in proportion to the violence of the symptoms, and from the cause of the disease being thus unconsciously applied for its removal, it could not fail to be aggravated, and hurried on to a fatal termination. At length, the observation of this fact, and of another truth, that a similar eruption did sometimes appear in patients who were using mercury for other complaints, and in whom no suspicion of syphilis could be entertained, led to the important discovery that the eruption was entirely an effect of mercury, and not at all connected with the original disease.

Dr. M<sup>c</sup>Mullin imputes the first explanation of the nature of the mercurial erythema to Drs. Moriarty and Spens, and Mr. George Alley, all which writers published in the course of the same year, viz. 1804. However, the passage which we have quoted above, from Mr. B. Bell's work on

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the venereal disease, clearly evinces that though the above gentlemen have undoubtedly great merit in having increased our information concerning the disease, yet the latter writer had noticed the affection before them. Indeed, Dr. Spens has had the liberality to make this acknowledgment himself.

According to Dr. M'Mullin, the different appearances which this disease assumes, from its severity and duration, may be best understood by describing it as consisting of three distinct stages. The first stage, says this gentleman, commences with languor, lassitude, and cold shiverings. These symptoms are succeeded by increased temperature of the body, quick pulse, nausea, head-ach, and thirst. The patient is troubled with a dry cough, and complains of difficult respiration, anxiety, and sense of stricture about the præcordia. The tongue is usually moist, and covered with a white glutinous slime. It sometimes appears clean and of a bright red colour in the centre, while the margins remain foul. The skin feels unusually hot and itchy, with a sense of prickling, not unlike the sensation experienced from the application of nettles. The belly is generally costive; but a diarrhœa is often produced by very slight causes.

To continue Dr. M'Mullin's description: on the first, or second day, an eruption most commonly appears, the colour of which is either dark or bright red. The papulæ are at first distinct and elevated, very much like those which occur in rubeola. Sometimes, but not often, the eruption appears like urticaria, and in such instances the disease is observed to be very mild. The papulæ very speedily run together in such a manner as to form a suffused redness, which disappears on pressure. In most cases, it first begins on the scrotum, inside of the thighs, fore-arm, or where mercurial frictions have been made, and the skin of the parts affected becomes considerably swollen. Instances have also been seen in which an eruption of a purplish colour, and accompanied by papulæ, has suddenly diffused itself over the whole body. (See Moriarty on *Lepra Mercurialis*.) Dr. M'Mullin remarks, however, that the latter form of the affection may be considered as uncommon. In every instance which Dr. M'Mullin has seen the eruption was at first confined to a few places, and thence gradually extended, until the different portions of the eruption had united. The papulæ were also rough to the feel. But, in such cases as resemble urticaria, many minute vesicles, interspersed among the papulæ, and containing a serous fluid, make their appearance from the very first. Contrary to what happens in most diseases, accompanied with cutaneous affections, the febrile symptoms are much aggravated, and continue to increase, after the eruption is complete. The pulse in general beats from 120 to 130 in a minute, the thirst continues urgent, and the patient, who is extremely restless, seldom enjoys quiet sleep. Dr. M'Mullin further informs us, that when the eruption has continued in this manner, for a certain period, the cuticle begins to peel off in thin, whitish, scurfy exfoliations, not unlike those observed in rubeola. This desquamation first begins where the eruption made its earliest appearance, and in this order spreads to other parts. About this period the fauces become sore, the tongue swells, and the eyes appear somewhat inflamed.

The duration of this stage is very various; sometimes it continues from ten to fourteen days, and in other cases it terminates in half that time. When the disease has appeared in its mildest form, the patient recovers immediately after this desquamation, a new cuticle having formed underneath. When the disease is severe, however, he has only

experienced the smallest part of his sufferings, and the skin now assumes a new appearance, which Dr. M'Mullin has considered as the second stage.

This author represents the skin as appearing at this period as if studded with innumerable minute vesicles, which are filled with a pellucid fluid. These vesicles (he observes) may be expected, if the patient, at the close of the first stage, should complain of increased itching, and a sense of a burning heat in the parts, from which the cuticular exfoliations have fallen. The vesicles sometimes remain for a day or two; but in general they are burst immediately after their formation, by the patient rubbing the parts, in order to relieve the troublesome itching which he suffers. A ferous acrimonious fluid is discharged, which possesses so disagreeable an odour, that it induces nausea in the patient himself, and those who approach his bed-side. The smell is said to be so peculiar, that it can be easily recognised by any person who has once perceived it. Dr. M'Mullin states, that this fluid is poured out most copiously from the scrotum, groin, inside of the thighs, or wherever the skin forms folds, and sebaceous glands are most numerous. The ferous discharge from the vesicles forms, with the cuticle, incrustations, which Dr. M'Mullin regards as the criterion of the third or last stage.

The same writer observes, that the crusts are generally very large, and when detached retain the figure of the parts from which they have fallen. Their colour is in general reddish, but it sometimes appears dark and dirty. Dr. M'Mullin conceives, that this period of the disease might be termed, with much propriety, the stage of *de-crustation*, in order to distinguish it more fully from the *des-quamation*, which has been already noticed. When the stage of decrustation appears, the fauces become more affected, the eyes intolerant of light, and the tarsi tender, inflamed, and sometimes turned inward. The crusts formed on the face, as in other parts of the body, before falling off, break so as to leave cracks and fissures, which horribly deform the countenance; and in consequence of the great swelling of the face the eye-lids are also completely closed. The back and hairy scalp are said to be the parts most backward in becoming affected, and, according to Dr. M'Mullin's account, they even sometimes escape entirely in very severe cases.

In this stage of the mercurial erythema the patient is under the necessity of avoiding every kind of motion, on account of the pain which it occasions, and which he compares with such a sensation as one may fancy would be produced by a cracking of the flesh. The crusts also fall off in such abundance, that the bed seems as if strewed with the cones of hops.

While the eruption is only making its appearance in one place, it may have attained its most advanced form in another part, so that all the different stages of the disease may be present at one time, in the same individual.

Typhus prevails throughout the whole course of the complaint; but, what is curious, the appetite continues in most cases unimpaired, and sometimes is even voracious.

Dr. M'Mullin also remarks, that when the catarrhal symptoms have continued during the progress of the complaint, they are particularly aggravated in the advanced stage of the case. The anxiety and pain in the breast are likewise stated to be very severe, attended with cough and bloody expectoration, the patient invariably feeling languid and dejected. The pulse becomes frequent, feeble, and irregular; the tongue black and parched; and, at length, diarrhœa, delirium, convulsions, gangrene of the surface of the body, and death, ensue.

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The mild form of the disease only goes through the first stage, and ends, as we have already described, in a slight desquamation, after a few days. When the affection is severe, however, it is often protracted more than two months, every stage of the eruption continuing proportionably longer; and when, in this manner, it has run its course, it repeatedly breaks out on the new surface, and passes through the same stages.

For the preceding history of the symptoms of the mercurial erythema, we feel ourselves highly indebted to Dr. M'Mullin. See *Edinburgh Medical and Surgical Journal*, vol. ii. p. 25, &c.

With the exception of one case, which Dr. Rutter has inserted in the eighteenth number of the journal just now mentioned, we have no instance recorded, in which the present disorder originated, without the patient being under the influence of mercury. Whether Dr. Rutter's example is to be considered as the same identical disease as the one which we have been describing, we shall not undertake to investigate. We shall only observe, that since it is very possible to mistake other complaints for the real mercurial erythema, we do not consider one solitary fact, resting on the judgment of an individual, who might differ in opinion concerning the nature of the disease, with the next medical practitioner consulted, a sufficient ground for implicitly believing, that such a disease as the mercurial erythema can be produced quite independently of the use of mercury.

In certain habits, every preparation of mercury, and every form of employing this medicine, seem capable of bringing on the disease. As the complaint was first taken notice of in patients who were afflicted with syphilis, it was supposed to be an anomalous form of the venereal disease. But, at last, the repeated appearance of the eruption in persons exempt from all suspicion of having any syphilitic symptoms, made surgeons convinced, that what is now commonly named the mercurial erythema had nothing venereal in its nature. However, since few out of the great number of patients, continually employing mercury, are afflicted with this erythema, medical writers have attempted a further explanation of the difficult subject of causes, by stating, that the mercurial erythema only takes place in such patients as have a certain undefinable peculiarity of constitution. The contemplative reader will at once perceive, that this is a vague and unphilosophical mode of accounting for the production of the disease, as the same sorry kind of explanation may be generally adopted in regard to every disorder, the immediate cause of which is totally unknown. Is it not a greater mark of prudence and good sense to confess our ignorance, under these circumstances, than to offer statements, wishing them to be considered as explanatory, while they do not convey any information whatever on the subject?

It has been supposed by some, among whom is Dr. Gregory of Edinburgh, that the application of cold to the body, while under the influence of mercury, is absolutely essential to the production of the disorder under consideration.

Notwithstanding there can be no reasonable doubt that the mercurial erythema is commonly excited by the use of mercury in some form or another, yet it appears from what Mr. Pearson has stated, that the disease is not always exasperated by a perseverance in the employment of the medicine. On some particular occasions, when this gentleman judged it to be of great moment to continue the mercurial frictions, the eruption neither spread universally, nor was it materially increased. The patients, however, did not get rid of the rash till the mercury was discontinued.

We have already noticed the opinion of Dr. Gregory

and some other practitioners, that exposure of the body to cold, at a time when the system is under the influence of mercury, is absolutely necessary for the production of the mercurial erythema. Mr. Pearson seems to entertain a very different sentiment; for, he observes, that he is not aware of any other cause, than the action of mercury on a particular kind of constitution being concerned. He acquaints us, that he has seen this cutaneous disease occur in private practice as well as the Lock hospital, where the strictest attention has been paid to the temperature of the apartment, to regimen, and to personal cleanliness. He has had no reason to believe that any one season of the year is more conducive to the disease than another; and he states that free exposure to the air, either in winter or summer, has not the least perceptible effect in exciting the eruption.

Mr. Pearson, as a general rule, recommends the employment of mercury to be immediately left off on the first appearance of the eruption; and though he seems to admit that the affection may be relieved by remedies, yet he is doubtful whether any plan of treatment has the power of interrupting its regular course, or abridging its duration. Mr. Pearson would by no means wish to insinuate, however, that the patient may not derive considerable benefit from medical assistance; his sufferings (he owns) may be greatly mitigated; many inconveniences may be remedied; his strength may be supported; and, in short, (says Mr. Pearson,) he may be so conducted through the disease, that his general state of health shall not suffer any material or permanent injury.

It is not enough to discontinue the employment of mercury. In large hospitals, and particularly such as are appropriated to venereal cases, the patient should be immediately removed from those wards which may have their atmosphere vitiated by the breathing of persons charged in general with mercury.

In the early stage of the mercurial erythema, Mr. Pearson recommends small doses, of antimonial powder, with saline draughts, or else the ammonia acetata. A gentle purgative should be given every three or four days, and opium is proper for appeasing the pain and irritation, and procuring sleep. Sometimes, says Mr. Pearson, opium mixed with camphor, or Hoffman's anodyne liquor, will have a better effect than when administered alone. When the discharge is no longer ichorous, and the tumefaction is subsiding, the same surgeon prescribes the liberal exhibition of sarsaparilla and bark. He has also thought, that the general sense of uneasiness has been lessened by the vitriolic acid, which proves at the same time grateful and refreshing.

The diet should be of a light and nourishing quality; but no fermenting liquors can be prudently allowed till the desquamation of the cuticle is somewhat advanced.

In order to diminish the pain arising from the irritation of the skin, the warm bath may be used as often as the patient's strength will permit. His linen and sheets, which are soon rendered hard and stiff by the discharge, should be very frequently changed. Mr. Pearson is also in the habit of covering every part, where excoriations occur, with a soft mild cerate, made of litharge plaster, yellow wax, and olive oil. This application is to be thickly spread on rollers, by which means it may be conveniently put wherever it is needed. The dressing should be changed twice a day.

Dr. M'Mullin has noticed, that, though in the early stage of the mercurial erythema, diaphoretics are indicated, yet the bowels are so irritable, that such medicines can scarcely be employed. For the same reason, he recom-

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mends us to be very cautious in giving mineral acids, ripe fruits, &c. This gentleman approves of the patient being kept in rather a warm temperature, and in a place where he can derive the advantage of a quick circulation of air. The bowels being weak, Dr. M'Mullin advises us only to employ the mildest purgatives, when medicines of this class are required.

With regard to the topical treatment, the latter gentleman says, that solutions of sulphate of zinc, and acetite of lead, sulphur ointment, and the decoction of oak-bark, have all been tried, but without any particular good, and he seems to prefer sprinkling the parts with powdered starch. To allay the cough and soreness of the fauces, he advises mucilaginous mixtures, containing a small proportion of opium.

When the incrustations become general, the fever always assumes more of the typhoid type. In this stage bark has been usually prescribed, with a view of supporting the strength; but Dr. M'Mullin remarks, that this medicine can never be given in sufficient quantity, owing to its affecting the stomach, or occasioning diarrhoea. In some instances, he observes, the cold infusion, conjoined with aromatics, has been best retained, and a little opium may be added to the doses. Opium, which this gentleman describes as improper in the first stage, may now be taken without any risk of unpleasant consequences. He states, that wine is the best remedy in this stage of the disease. Porter and diluted spirit are also proper, and the thirst must be assuaged with whey, light broths, and nourishing drinks of every kind. Owing to there being now a large extent of the skin in an excoriated state, the patient cannot at this time generally bear warm bathing, which often brings on a state of syncope, and all that can be done is to wash the parts, in the most tender manner, with tepid water.

For the ophthalmia tarsi, the unguentum zinci vitriolati is recommended, and the linimentum aquæ calcis is said to relieve most effectually the pain which makes the patient feel as if his flesh were cracking.

We shall conclude this article with advising the reader, who wishes to be perfectly acquainted with the subject of mercurial erythema, to consult B. Bell's Treatise on Gonorrhœa Virulenta and Lues Venerea, vol. ii. p. 228. Pearson on the Effects of various Articles in the Cure of Lues Venerea. Edit. 2. p. 165. An Essay on a Peculiar Eruptive Disease arising from the Exhibition of Mercury, by G. Alley, Dublin, 1804. A Description of the Mercurial Leprosy, by Dr. Moriarty, Dublin, 1804. History of Three Cases of Erythema Mercuriale, by Dr. Spens, in Edinb. Med. and Surgical Journal, vol. i. p. 7. Essay on Erythema Mercuriale, by Dr. M'Mullin, in Edinb. Med. and Surgical Journal, vol. ii. p. 25. Case of Erythema not occasioned by Mercury, by John Rutter, M. D. in Edinb. Med. and Surgical Journal, vol. v. p. 143.

ERYTHRÆ, in *Ancient Geography*, a town of Greece, in Bœotia. Pliny. It was situated near mount Citheron, according to Euripides. Some authors place it in the territory of Plataea, to the east of this town.—Also, a town of Greece, in Thessaly, situated upon the river Erypæus, according to Strabo.—Also, a town of Greece, in Cœtolia, near Eupalium.—Also, a town in the isle of Cyprus, called Paphos.—Also, one of the twelve towns of Asia Minor, in Ionia, according to Pliny. Strabo says, that it gave name to the Erythrean Sibyl. He says also, that it had a port, called Cyssus, in which were four isles called Hippis. This town was built by Nilæus, the son of Codrus. In the town was a temple of Hercules, one of the most stately edifices in all Asia. Erythræ took part, on all occasions, with the Romans, who rewarded its fidelity with ample privi-

leges, and considerably enlarged its territory. It is now a village, named Erethri.—Also, a town of Africa, in Libya.

ERYTHRÆA, in *Botany*, *ερυθρα*, red, a name given by Renealm to the *Chironia Centaurium*, (*Gentiana Centaurium* of Linnæus), on account of its red colour, unusual in the Gentian tribe. This writer controverts the universally received opinion of its being the *ερυθρα* of Dioscorides, because the latter is said to prefer watery situations. But neither this, nor indeed any other of his arguments, is of much weight; for the *Chironia Centaurium* often occurs in low and wet places, and according to Dr. Sibthorp is very frequent throughout Greece. *Chironia spicata*, which Dioscorides would hardly distinguish from it, always grows in marshy spots, and is found on the coasts of Greece, as may also *Chironia pulchella*, though scarcely distinguished by any body from the common kind when Dr. Sibthorp visited that country, and therefore not noted by him.

ERYTHRÆAN SEA, in *Ancient Geography*, is the ancient name of the *Red Sea*. Indeed, the ancients gave this name to the whole expanse of water that extends from the coast of Ethiopia to the island of Taprobana. This appellation was probably derived from Edom or Esau, whose descendants were called Idumæans, and inhabited the northern part of Arabia. The Idumæans navigated upon the Red sea and the Persian gulf, and also upon the Indian sea, and the oriental name Idumæan signified red. Whence the sea of the Idumæans was called the Red sea, and the Erythrean sea.

ERYTHRÆAN Sibyl. See SIBYL.

ERYTHREAN, an appellation given to Hercules, from a temple which he had at Erythres, in Arcadia.

ERYTHRINA, in *Botany*, from *ερυθρος*, red, on account of the scarlet flowers, whence also it is called Coral-tree. Linn. Gen. 365. Schreb. 486. Willd. Sp. Pl. v. 3. 912. Mart. Mill. Dict. v. 2. Juss. 356. (Coralodendron; Tournef. t. 446.) Class and order, *Diadelphia Decandria*. Nat. Ord. *Papilionacea*, Linn. *Leguminosa*, Juss.

Gen. Ch. Cal. Perianth of one leaf, entire, tubular; its margin more or less two-lobed; its base on the lower side furnished with a honey-bearing pore. Cor. papilionaceous, generally of five petals; standard much the longest, lanceolate, ascending, its sides bent downwards; wings minute, somewhat ovate, scarcely longer than the calyx, and hardly reaching beyond the claw of the standard; keel straightish, usually about the length of the wings, sometimes longer, of two petals either separate or united, notched at the end. Stam. Filaments ten, unequal, united below into a tube, slit at the upper edge, a little incurved, half as long as the standard, one of them occasionally separate; anthers ten, oblong. Pist. Germen superior, stalked, awl-shaped, tapering into an awl-shaped style, as long as the stamens; stigma terminal, simple. Peric. Legume very long, protuberant from the seeds, pointed, of one cell. Seeds several, kidney-shaped.

Ess. Ch. Calyx two-lobed, standard much longer than the keel. Wings minute. Legume cylindrical, with many convex seeds.

Obs. *E. herbacea* has the tenth stamen separate; which is also the case with *E. Crista-galli*, whose keel moreover has its petals united into one, and is much longer than in the generality of the species.

The species of this splendid genus are, for the most part, natives of very hot climates in the East or West Indies, and amount in Willdenow, who has paid particular attention to them, and described two new ones, to twelve.

*E. herbacea*, Linn. Sp. Pl. 992. Trew. Ehret. t. 58. found

in Carolina, will support our winters in a green-house, nor does its stem always die down to the root. The flowers form long and very handsome spikes, being of a most vivid though deep scarlet, with purplish stalks and calyx. Seeds scarlet with a black eye.

*E. Corallodendrum*, Linn. Sp. Pl. 992, brought from the West Indies, requires a stove. It has an arborefcnt prickly stem, with flowers much like the former.

*E. mitis*, Jacq. Hort. Schoenbr. v. 2. 47. t. 216, is another similar species in its flowers, but destitute of prickles. It was sent to the Imperial garden from the Caraccas.

*E. Crista-galli*, Linn. Mant. 99. Sm. Exot. Bot. v. 2. 69. t. 95, is perhaps one of the most lately of the whole. This is said to be a native of Brasil, but was raised in the Liverpool garden from seeds brought from the East Indies, probably from the garden at Calcutta. It was in 1805 but a slender prickly shrub about six feet high, with ternate prickly-ribbed leaves. Flowers in large terminal clusters, of a rich unpolished deep scarlet, their standards much broader, and keels much longer, than is usual in this genus; the wings very small and three-lobed, of a greenish white. Tenth filament separate to the very base.

*E. speciosa*, Andr. Repof. t. 443, a plant we have never seen, flowered in the garden of A. B. Lambert, esq., and though supposed to be a native of South America, is said to be perfectly hardy, and to strike very freely from cuttings. Whether it be comprehended under any of Willdenow's species, we are not at all certain. The stem is prickly, thick and strong. Leaflets very broad, with prickly ribs. Flowers scarlet, in very dense spikes. Wings half as long as the standard, which is narrow like the first species; keel not half so long as the wings. If these circumstances are constant, the generic character will require correction.

ERYTHRINUS, in *Ichthyology*, a species of SPARUS and also of SALMO, which see respectively.

ERYTHROCEANEUS, in *Ornithology*, the red and blue maccaw, with a wedge-like tail, and the sides of the head naked and rough. See PSITTACUS.

ERYTHRODANUM, in the *Materia Medica*, a name by which some authors have called the rubia tinctorum, or madder.

ERYTHROIDES, in *Anatomy*, from *ερυθρος*, red, and *ειδος*, form, a name given by some anatomists to the first proper covering of the testicles. It is not now admitted that these bodies are covered by any thing except the fibres of the cremaster and cellular substance of the scrotum, to which, perhaps, the above-mentioned name may have been applied.

ERYTHRONIUM, in *Botany*, from *ερυθρος*, red, in allusion either to the colour of the flower, or to the more unusual blood-like stain in the leaves. Dog's-tooth Violet. Linn. Gen. 165. Schreb. 220. Willd. Sp. Pl. v. 2. 96. Mart. Mill. Dict. v. 2. Juss. 48. (*Dens canis*; Tournef. t. 202.) Class and order, *Hexandria Monogynia*. Nat. Ord. *Sarmentaceae*, Linn. *Lilia*, Juss.

Gen. Ch. *Cal.* none. *Cor.* Petals six, regular, lanceolate, pointed, lying over one another alternately towards the base, spreading gradually, reflexed from about the middle; three of them external, three internal. Nectary two scars, or little scales, at the base of each of the inner petals. *Stam.* Filaments six, uniform, awl-shaped, short; anthers oblong, erect, as long as the filaments. *Pist.* Germen superior, roundish or oblong, with three angles; style simple, shorter than the corolla, taper at the base, and a little bent at that part, otherwise straight; stigmas three, spreading, somewhat cylindrical, furrowed, or notched. *Peric.* Capsule nearly

globular, contracted at the base, of three cells and three valves. Seeds numerous, ovate, pointed.

Eff. Ch. Corolla bell-shaped, of six reflexed petals. Nectary two scars at the base of the three inner ones. Capsule globose, contracted at the bottom. Seeds ovate.

1. *E. Dens canis*. Linn. Sp. 437. Jacq. Austr. v. 5. 31. append. t. 9. Curt. Mag. t. 5. Leaves with a blunt flat point. Style cylindrical. Germen globose, obtuse. Native of mountainous places in Italy, Switzerland, Carniola, Styria, Carinthia and Tartary, flowering in the spring. In our gardens it is a hardy perennial, distinguished by its elliptical radical leaves, very various in breadth, elegantly stained with purple, and its solitary drooping crimson or whitish flower, with pendulous dark purple anthers. No remains of the herbage are to be seen after the end of June. Lobel and several botanists of his time presumed this to be the real *σατυριον* of Dioscorides, nor does it ill accord with the description, though Dr. Sibthorp seems not to have met with the plant in Greece. It cannot, however, be made to agree with the *σατυριον* *ερυθρονιον* of the same author, though the latter appellation seems to have given rise to its present generic name. The old authors made two species on account of the various dimensions of the leaves, which Linnæus reduced to one, but he very improperly made a third variety of the following species.

2. *E. flavum*. (*E. americanum*; Curt. Mag. t. 1113. *E. Dens caris* γ; Linn. Sp. Pl. 437.) Leaves involute at the point. Style club-shaped. Native of the colder parts of North America. It flowered in April 1808, in the gardens of Mr. Loddiges at Hackney, and Mr. Salisbury at Brompton, and was first well determined by Mr. Gawler in Curtis's Mag. The leaves resemble the former, except in having a hooded termination, from the involute edges of the point. Flower deep yellow spotted with red. Anthers and pollen yellow. Style very thick in the upper half. Germen obovate.

3. *E. revolutum*. Leaves flat-pointed? Style cylindrical. Germen elliptic-oblong, acute. Gathered by Mr. A. Menzies on the west coast of North America. The leaves are broadly elliptical, and in our specimens appear pale, and scarcely spotted. Petals purplish, very much rolled back, as in the Martagon Lily. Stamens with unusually long taper-pointed filaments, and pale or yellowish, not dark purple, anthers. Germen elliptic-lanceolate, pointed. Style contracted at the base, but otherwise pretty exactly cylindrical, with much longer stigmas than either of the foregoing.—The whole plant also is larger, and appears to us unquestionably distinct. The discovery of this species in America renders the original name of the last so exceptionable, that we hope we may be pardoned for changing it before it is adopted in any regular synoptical work, otherwise it would be too late. S.

ERYTHROPTHALMUS, in *Ichthyology*. See CRPRINUS.

ERYTHRORHIZA, in *Botany*, *ερυθρη ριζα*, a red root; Michaux Fl. Boreali-Amér. v. 2. 36. t. 36, is *Galax aphylla*, which see.

ERYTHROXYLUM, *ερυθρον ξυλον*, red wood. Brown. Jam. 278. Linn. Gen. 228. Schreb. 307. Willd. Sp. Pl. v. 2. 746. Mart. Mill. Dict. v. 2. Juss. 253. Class and order, *Decandria Trigynia*. Nat. Ord. *Tribilata*, Linn. *Malpighie*, Juss.

Gen. Ch. *Cal.* Perianth of one leaf, turbinate, very small, withering, in five ovate acute segments. *Cor.* Petals five, ovate, concave, spreading. Nectary an upright, coloured, notched scale, attached to the base of each petal. *Stam.* Filaments 10, the length of the corolla, connected at the base by an

abrupt membrane; anthers heart-shaped. *Pist.* Germen ovate, superior; styles three, thread-shaped, distant, the length of the stamens; stigmas thickish and obtuse. *Peric.* Drupa ovate, of one cell. *Seed.* Nut oblong, with four obtuse angles.

*Ess.* Ch. Calyx turbinate. Petals five, each with a notched nectariferous scale at its base. Stamens connected at their base. Drupa of one cell.

This genus, founded by Browne, consists of two species only in his work. 1. *E. areolatum*, Linn. Sp. Pl. 612. Brown. Jam. t. 38. f. 2. and t. 14. f. 3. (*E. carthaginense*; Jacq. Amer. 134. t. 87. f. 1.) This is called, in Jamaica, Red Wood, or Iron Wood, and is said to be excellent for the size of the tree, which is not above five or six inches in diameter. The leaves are obovate, two inches long, marked with two lines at the back, which circumscribe the part that was exposed before each leaf expanded. Flowers starry, white, fragrant, on simple, clustered, lateral stalks.

2. The second species of Browne has been neglected by following authors, probably as a variety of the first. He describes it as different in its manner of growth, with smaller rounder leaves.

Cavanilles and Lamarck have much increased the number of species, so that they now amount in Willdenow's work to 12, all except the above unknown to Linnæus. They are natives either of South America, Madagascar, or the islands of Mauritius and Bourbon, and were chiefly gathered by Commerçon. The French call many of them Bois d'huile. The wood is, in some instances, said to have a very strong and disagreeable smell while burning.

ERYX, in *Ancient Geography*. See ERIX.

ERYX, in *Zoology*, a species of ANGUIS, being the *Anguis dorso trilineato* of Boddaert, above cinereous, with three black lines, and light blueish beneath. It is found in England, and in America.

ERZ, or ERZI, in the *Botanical Writings of the Ancients*, a word used originally by the Hebrews, and by them made the name of the cedar.

ERZEN, in *Geography*, a town of Germany, in the circle of Lower Saxony, and principality of Calenberg, seated on the Humme; 7 miles S.W. of Hameln.

ERZERUM, or ARZERUM, a city of Asiatic Turkey, and capital of a pachalic to which it gives name, and is a part of Armenia, situated near the head of the Euphrates, at the foot of a chain of mountains which are usually covered with snow till the latter end of spring. The town is surrounded with a double wall, and defended with some square towers; the houses are mean, and none of them large. The suburbs are inhabited by Christians. Of the inhabitants, they count 18,000 Turks, of whom two-thirds are Janizaries; 6000 Armenians, who have an archbishop, and two churches; and 400 Greeks, who have a bishop, and one mean church. The Greeks are mostly employed in the manufacture of copper, brought from some mines three days journey from the city; this, and the manufacture of the skin of a species of martin, are the only articles of their commerce. Erzerum is the staple of the merchandize of India, especially when the Arabians infest the environs of Aleppo and Bagdad. This merchandize consists of silk from Persia, cotton, painted linens, spices, rhubarb from Bucharia, madder from Persia, zedoary, &c. This town was one of the last which was taken from the Greek emperors by the Arabians; 250 miles N.N.E. of Aleppo, and 510 E. of Constantinople.

ERZGEBIRG. See ERTZGEBIRGE.

ESAPHE, from εσαφη, *I feel with the fingers*, a word used by Hippocrates, to express the touching of the mouth of the uterus, in order to discover its state of disease.

ESAU, in *Biography*, the son of Isaac and Rebecca, and the twin-brother of Jacob, whom he succeeded at his birth, was born in the year 1836 B.C. At his birth he was covered with hair, indicating great bodily strength, by which he was fitted for the kind of life to which he afterwards devoted himself. As he was fond of hunting, he supplied his father with a variety of delicious food, and became his favourite. Jacob, however, was the favourite of his mother, and by means of a circumstance mentioned in his history, supplanted Esau of his birth-right, which he consented to barter for a mess of red pottage, that had been prepared for their father, during his absence. Hence he and his posterity derived the appellation of Edom, signifying red. At the age of 40 years Esau distressed his parents by marrying two wives out of idolatrous Canaanitish families, with which the posterity of Abraham were prohibited from forming any connection. In process of time, he regained his father's favour, and as death approached, Isaac determined to confer his last prophetic benediction on Esau, as his first-born son and heir. The artifice of his mother, however, counteracted his purpose; and she contrived to impose upon Isaac, and to obtain the father's parental blessing for her son Jacob. Esau was indignant on account of the treatment of his brother; and determined to kill him as soon as their father should die.

Rebecca again interposed, and sent Jacob away to her brother Laban, with whom he might be secure from the threatened vengeance of his brother. During the period of separation, which lasted several years, Esau married a wife of the family of Ishmael, and removing to mount Seir, acquired great power and wealth. When Jacob returned, after long absence, to his father's country, with a numerous family, and large flocks and herds, he dreaded his brother's displeasure; and though they had an amicable and affectionate interview, he entertained suspicion of remaining resentment, and instead of complying with the wishes of his brother, who was desirous that he would settle in his neighbourhood, he dwelt in Shechem. After their father's death they lived in peace and amity; but as their possessions enlarged, and there was not sufficient room for them in the land in which they were strangers, Esau returned to mount Seir, where his posterity multiplied under the denomination of Edomites. (See EDOM.) The time of his death is not mentioned, but bishop Cumberland thinks it probable that he died about the same time with his brother Jacob, at the age of about 147 years. Genesis, ch. xxv—xxxvi.

ESAU, in *Geography*, a mountain of Arabia, in the country of Yemen, 4 miles N. of Udden.

ESAULOVO, a town of Russian Siberia, in the government of Kolivan; 36 miles E.S.E. of Krasnoiarsk.

ESBONITÆ, in *Ancient Geography*, a people of Arabia-Petræa, who took their name from the capital, which was seated in the mountains over-against Jericho.

ESBUS. See HESHBON.

ESCACENA, in *Geography*, a town of Spain, in the country of Seville; 20 miles W. of Seville.

ESCAILLON, a river of France, which runs into the Scheldt, about two miles above Valenciennes.

ESCALA, LA, a town of Spain, in the province of Catalonia, on the coast of the Mediterranean; 22 miles E. of Gerona.

ESCALADE, or SCALADE, in the *Military Art*, a furious attack of a wall or a rampart; carried on with ladders, to pass the ditch, or mount the rampart; without proceeding in form, breaking ground, or carrying on regular works to secure the men.

When the troops are prepared to pass the ditch, either with

with the assistance of boards, hurdles, and fascines, when it is muddy, or with small boats of tin, or baskets covered with skins, or oil-cloth when it is deep, and filled with water, a party must be placed on the counterescarp, opposite to the landing-place, ready to fire at the garrison if they are alarmed, and oppose the mounting on the rampart. If the ditch is dry, the ladders are fixed in some place farthest distant from the centre; and as soon as they get upon the rampart, they put themselves in order to receive the enemy; if the centre should be surprised, and silently overcome, the detachment halloos to break open the gate, and to let in the rest of the party. If the ditch is wet, the rampart high, and provided with a revetement, it will be difficult to surprise the town in this way; but if there is no revetement, the troops may hide themselves along the outside of the rampart till all are over. Since the invention and use of gun-powder, and the walls of cities have been flanked, they are seldom taken by escalade.

ESCALANA, in *Geography*, a town of Spain, in Old Castile; 14 miles N.N.E. of Segovia.

ESCALANTE, a town of Spain, in the province of Biscay; 15 miles E. of Santander.

ESCALAON, a town of Portugal, in the province of Beira; 16 miles N. of Almeida.

ESCALLION, in *Botany*. See SCALLION.

ESCALLONIA, so called by the younger Linnæus, at the recommendation of Mutis, in honour of a learned Spaniard named Escallon, the pupil of Mutis in botany, mathematics and philosophy, and his inseparable companion during his abode in New Spain. This gentleman discovered the shrub in question, as well as a vast number of new or rare plants besides, in his various journeys through New Granada, most of which were, by Mutis or himself, communicated to Linnæus or his son. A very fine plant was originally chosen by Mutis for the above purpose, of which a specimen and drawing were sent to Linnæus; but it proved, on a careful examination, to be a *Loranthus*, and remains undescribed in the Linnæan herbarium.—Linn. Suppl. 21. Schreb. 152. Willd. Sp. Pl. v. 1. 1149. Mart. Mill. Diet. v. 2. Juss. 321. Class and order, *Pimentaria Monogynia*. Nat. Ord. *Onagrea*, Juss.

Gen. Ch. Cal. Perianth of one leaf, inferior, hemispherical, with five large, spreading, ovate, acute, permanent teeth. Cr. Petals five, equal, inserted into the calyx, tongue-shaped or obovate, obtuse, a little distant from each other, longer than the calyx-teeth. Stam. Filaments five, equal, erect, awl-shaped, inserted into the calyx between the petals, opposite to its teeth and about the same length; anthers incumbent. Pist. Germen half invested with the calyx, globular; style cylindrical, straight, the length of the stamens; stigma capitate, umbilicate. Peric. Berry roundish, of two cells, crowned with the calyx-teeth. Seeds very numerous, minute.

Ess. Ch. Berry of two cells, with many seeds. Calyx encompassing the fruit. Stigma capitate. Petals five, inserted into the calyx.

1. *E. myrtilloides*. Linn. Suppl. 156. Sm. Pl. Ic. t. 30.—Leaves finely serrated, minutely pointed, veiny beneath. Flowers solitary.—Gathered in New Granada by Escallon.—Stem shrubby, branched, slightly angular, with a smooth deciduous bark. Young branches numerous, alternate, short, simple, leafy, each terminated by a solitary, stalked, terminal flower. Leaves alternate, spreading, about three-quarters of an inch long, obovate, obtuse with a minute point, minutely serrated, especially towards the end, smooth, deciduous; with no perceptible veins on the upper side; paler and veiny beneath; the base tapering down into a

short, often fringed, footstalk, each of whose edges unites at their base with a glandular toothed angle or rib in the branch. *Stipulas* none. *Flower-stalks* angular and glandular. *Petals* about thrice as long as the calyx-teeth, apparently white, erect, their extremities reflexed. *Berry* black? the size of a large pea, or bigger, crowned with the calyx and base of the style.

2. *E. ferrata*. Sm. Pl. Ic. t. 31.—Leaves serrated, somewhat abrupt, smooth and without veins at the back. Flowers solitary.—Gathered about the straits of Magellan, by Commerçon; in Staten land, (not Terra del Fuego,) by Mr. Archibald Menzies.—A humble branched smooth shrub, with something of the aspect of a *Vaccinium*. Branches alternate, somewhat zig-zag, angular, with a pale smooth bark; those of the present season green, leafy, straighter, each bearing a solitary, terminal, stalked flower. Leaves deciduous, alternate, obovate, obtuse, often abrupt or retuse, with a minute central point or tooth, equally serrated or somewhat crenate, very smooth; slightly veiny above; pale and destitute of lateral veins beneath, though furnished like the former with a strong central rib. *Footstalks* smooth and entire, as are the angles of the branches. *Stipulas* none. *Flower-stalk* smooth. *Petals* white, spreading, not recurved. Top of the *germen* violet. All the parts of fructification, except the petals, are but one-third the size of the former. The little *berries*, crowned with the permanent style, appear to remain through the winter, and their upper part, above the calyx-teeth, easily separates like a lid as they ripen, exposing the pulp full of small seeds, with its transverse partition.

3. *E. glandulosa*. Leaves double serrated, acute, glandular at the back like the branches. Flowers somewhat corymbose.—Gathered in Chili by Mr. A. Menzies.—Branches wand-like, roundish, leafy, when young clothed with abundance of prominent glandular tubercles. Leaves alternate, when full grown near an inch and half long, obovate, pointed, strongly and doubly serrated; smooth or slightly downy above; veiny, and rough with innumerable prominent resinous glands, beneath; tapering at the base into a shortish glandular footstalk. Each leaf is accompanied by an axillary tuft of smaller ones, the rudiments of future branches. *Stipulas* none. *Flower-stalks* several about the tops of the branches, axillary and terminal, simple or subdivided, each about an inch long, angular, glandular like the branches, as is also the base of the calyx. *Bractæas* few, at the base or subdivision of each stalk, linear, glandular. *Calyx* about the size of the last. *Petals* more like the former, and somewhat longer, with rounded, reflexed extremities. *Style* furrowed, surrounded at its base with an annular lobed gland or nectary, of which we can find no traces in the other species. *Germen* of two cells. The fruit we have not seen. S.

ESCALONA, in *Geography*, a small, tolerably built, walled town of Spain, in the province of New Castile, with several suburbs, seated on an eminence defended by a castle, in a fruitful spot watered by the Alberche, 20 miles N.W. of Toledo, and 32 S.W. of Madrid. It has four churches, and two convents.

ESCALOP *Fossil Shells*, in *Conchology*, are described by Da Costa (*Conchol.* p. 247.) as found in the lime-stone quarries at Thame in Oxfordshire; Mr. Walcot, in his "Petrefactions found near Bath," has also described a singular kind of shell, as found in the clay on the side of the road between Claverton-Down and village, and in the free-stone at the quarries near King's Down; and another kind found in a slaty loam at the limestone quarry near the Crescent in Bath.

**ESCAMBIA**, one of the most considerable rivers that fall into the bay of Pensacola, in West Florida, discharges itself near the head of the north branch, about 12 or 15 miles from Pensacola, through several marshes and channels which have a number of islands between them, that are overflowed when the water is high. The course of this river from an unknown source is very winding. The lands on each side are, in general, rich, low, or swampy, or well adapted for the culture of rice or corn. The numerous rivulets that fall into this river from the high country about it may be led over every part of the rice lands, at any season of the year. The islands at the mouth of the river, of which some are considerable in extent, are not inferior for rice to any in America.

**ESCAMBIO**, from the Spanish *cambiar*, to change, was anciently a licence granted any one for making a remittance, or giving a bill of exchange to another, beyond sea.

For, by stat. 5 Rich. II. no person might exchange, or return money beyond sea, without the king's licence.

**ESCAMUS**, in *Ancient Geography*, a river of Mœsia, which has its source in mount Hæmus.

**ESCAPE, FIRE.** See **FIRE-ESCAPE.**

**ESCAPE**, in *Law*, an evasion out of some lawful restraint, either by violence or stealth.

Escapes are either *voluntary*, or *negligent*.

*Voluntary*, are such as are, by the express consent of the keeper to whose custody, in civil actions, the debtor has been committed; after which, he can never retake his prisoner again, (3 Rep. 52. 1 Sid. 330.) though the plaintiff may retake him at any time, (stat. 8 or 9 W. III. c. 27.); but the sheriff must answer for the debt.

*Negligent* escapes are where the prisoner escapes without his keeper's knowledge or consent; and then upon fresh pursuit the defendant may be retaken, and the sheriff shall be excused, if he has him again before any action brought against himself for the escape. (F. N. B. 130.) A rescue of a prisoner in execution, (which see,) either going to gaol or in gaol, or a breach of prison will not excuse the sheriff from being guilty of and answering for the escape; for he ought to have sufficient force to keep him, since he may command the power of the county (Cro. Jac. 419.)

An escape of a person arrested upon criminal process, by eluding the vigilance of his keepers before he is put in hold, is an offence against public justice; and the party himself is punishable by fine or imprisonment. (2 Hawk. P. C. c. 122.) But the officer permitting such escape, either by negligence or connivance, is much more culpable than the prisoner. Officers, therefore, who, after arrest, negligently permit a felon to escape, are punishable by fine (1 Hal. P. C. 600.); but *voluntary* escapes, by consent and connivance of the officer, are a much more serious offence; for it is generally agreed that such escapes amount to the same kind of offence, and are punishable in the same degree, as the offence of which the prisoner is guilty, and for which he is in custody, whether treason, felony, or trespass; and this, whether he was actually committed to gaol, or only under a bare arrest. (1 Hal. P. C. 590. 2 Hawk. P. C. 124.) But the officer cannot be thus punished, till the original delinquent hath actually received judgment or been attainted, upon verdict, confession, or outlawry, of the crime for which he was so committed or arrested; and otherwise it might happen, that the officer might be punished for treason or felony, and the person arrested, and escaping, might turn out to be an innocent man. But before the conviction of the principal party, the officer thus neglecting his duty may be fined and imprisoned for a misdemeanor. (1 Hal. P. C. 588, 9. 2 Hawk. P. C. 134, 5.) See **RESCUE.**

**ESCAPE warrant.** If any person committed or charged in custody in the king's bench, or Fleet prison, in execution, or on mesne process, &c. go at large; on oath thereof before a judge of the court where the action was brought, an escape warrant shall be granted, directed to all sheriffs, &c. throughout England, to retake the prisoner, and commit him to gaol when taken, there to remain until the debt is satisfied; and a person may be taken on a Sunday upon an escape warrant. Stat. 1 Anne, cap. 6.

**ESCAPEMENT**, in *Horology*, is an ingenious mechanical contrivance for transmitting, in a modified way, and at equidistant intervals of time, the maintaining power of a clock or watch to the regulator, whether balance or pendulum, in order to restore that loss of motion in every vibration or oscillation, which necessarily arises from the friction of the acting parts, and the resistance of the air in every machine. It has been said, under the article **CLOCK**, that the maintaining power, whether consisting of a weight or spring, when suffered to expend itself unrestrained, would make the wheel-work run on with an increasing velocity, until the obstacles to motion, such as the friction in the teeth and at the pivots, the resistance of the air, &c. fixed the maximum of velocity with which it could expend itself; at which period the friction and resistance would jointly operate as a regulator, whilst they and the maintaining power remained unaltered, and the machine so circumstanced would greatly resemble a common kitchen-jack; and if an index were inserted on the arbor of the first or slowly moving wheel, it would indicate such portions of time as the ratio between the maintaining power and the regulating friction and resistance of the air taken together would produce; but it is obvious, that every alteration produced in the friction by wear, foulness, &c. or in the density of the air by the state of the atmosphere, would affect the indication so much, as to render it extremely irregular; hence the balance and the pendulum were successively invented and applied to regulate the indication of time by their isochronous vibrations; but then as both these regulators have alternate motions backwards and forwards, they could neither of them be applied immediately to check a wheel that moves continually in one direction, without the intervention of some contrivance, connected both with the wheel and regulator, which should convert a direct circular motion into a motion changing its direction by perpetual alternations. To devise and execute a piece of mechanism that should perform such an office steadily and accurately, required much science as well as mechanical skill, and the invention once executed was denominated an *escapement*, or by contraction among the workmen *scapement*, because it suffers a tooth of the wheel, with which it acts, to *escape*, or pass on, at such intervals of time as are measured by the regulator, which wheel is therefore also called the *escapement wheel*.

From this short account of the origin and office of an escapement, the reader will perceive, that the accuracy of its construction constitutes one of the most essential considerations in an horometrical machine, it being an indispensable condition, that the successive impulses taken from the maintaining power through the medium of the wheel-work, and given to the regulator, should be so modified, as to disturb as little as possible the natural isochronism of the regulator, or, if it do disturb it, that it should somehow compensate that disturbance. Hence it becomes necessary, that the workman, or mechanician, should be fully acquainted with the theory of the natural isochronism of his proposed regulator, when he undertakes to design and execute his escapement; he must not only know how much of the

## ESCAPEMENT.

maintaining power will be sufficient to balance the loss sustained in the natural length of a vibration, by reason of friction and the resistance of a standard medium, but he must consider and indeed ascertain, by theory or experiment, or both, at what part of the arc of vibration the power must be applied; likewise how long the impulsion shall continue to act, and whether that action ought to be uniform, increasing, or decreasing in its intensity. These and similar considerations have produced, as might be expected, a great variety of constructions of an escapement, both with regard to their external shape and *modus operandi*. As a good escapement is of the utmost importance in the useful art of clock-making, and as we have no author in the English language who has given us the different constructions in historical order, together with such remarks as may enable the reader to judge of their respective excellence, we will devote some time to the detail of both the theory and practical construction of such different escapements as seem to merit a general notice.

But before we enter upon our description and examination of different escapements of clocks and watches, as the reader has not yet had an opportunity of perusing the article **PENDULUM**, and as all escapements derive their shape and manner of action from the relation they bear either to the laws of its motion, or to those of a moving balance, it will contribute greatly to his better understanding the subject, if we premise first some of the chief circumstances which relate to the theory of a free pendulum, and to the influence that any external impulse will have on it when applied to become the regulator of a clock; and secondly, if we explain the theory of a balance's motion, which we have purposely reserved for this place by reason of its intimate connection with the escapement.

1. In *fig. 1. of Plate XXXI. of Horology*, let *CD* represent a *free pendulum*, or pendulum that has no weight but what is collected at the centre of oscillation or point *D*, and let the arc *DB* represent a semi-vibration round the point *C*, taken as the centre of motion or point of suspension, at which we will suppose there is no friction, then if the resistance of the air and rigidity of the string or rod were not to interfere, when the pendulum was once removed from its natural or perpendicular situation *CD* to *B*, and suffered to descend again by the sole force of gravity, it would acquire such a velocity at its lowest point *D*, by means of the accelerating force of gravity, as would, under these circumstances, carry it up an equal semi-vibration or arc *DG*, the increments of accelerated motion being equal in the arc *BD* to the decrements of retarded motion in the equal arc *DG*, the same reasoning would apply in the returning vibration from *G* to *B*; the velocity acquired at *D* by the descent from *G* to *D* would carry the pendulum again up to *B*, and the consequence would be, under such *natural* circumstances, if they could be effected, that there would be a perpetual alternation of vibrations of the same length, which would consequently be isochronal with respect to each other, so long as the pendulum remained of the same length; and such a pendulum would of itself be a perfect time-measurer, and would only want a register to indicate the number of its vibrations, to make it a complete regulator or chronometer: but the fact is, the friction and rigidity at the point of suspension cannot by human art be entirely annihilated, though ingenuity can greatly diminish it; nor can the obstacle to free motion arising from the resistance of the air be removed, or even rendered uniform; hence it is found that when a pendulum is drawn aside from its point of rest, every succeeding vibration, after motion has commenced, is somewhat shorter than the pre-

ceding one; until after some hours have been spent in alternate vibrations continually shortening, the pendulum finds its original point of rest; the time expended in doing this is longer in proportion to the diminution of friction, the air and other circumstances remaining unchanged. Ferdinand Berthoud, the famous French clock-maker, made some experiments to ascertain this fact, and constructed the knife-edge suspension of a second's pendulum, with a heavy lenticular ball, so free from friction, that an arc of vibration of  $10^\circ$  was not reduced to  $15'$  till  $29^h 46^m$  had elapsed; but notwithstanding every attempt to reduce the friction, the pendulum came to rest at last. From this short view of the tendency of a pendulum to come to rest after it has had a motion communicated to it, we clearly perceive the necessity of making some auxiliary additions to the natural force of gravity, in order that the pendulum may keep up the length of its original vibration in every succeeding one, notwithstanding the obstructions which continually oppose the operation of gravity; these auxiliary additions to the motion, produced by gravity only, constitute the operation of the maintaining power, modified by the wheel-work and escapement, in every pendulum clock; and hence arises a *disturbance* in the *theory* of the free pendulum, which makes such a theory no farther of use in clock-work, than as it affords certain laws and a scale of forces, such as the mechanician may labour to imitate, by modifying the joint agency of his *auxiliary additions* and of the operation of gravity, so that they shall act in concert; which imitation is to be effected principally, as to its *mode*, by the escapement, the maintaining power being concerned only as to the *quantity* of any additional power to be applied in aid of gravity.— Now, if we suppose the pendulum at the situation *B*, or extremity of its arc, and draw *AB* perpendicular to the vertical line *CD*, and *BE = CB* perpendicular to the line *AB*, or, which is the same thing, parallel to the line *CD*; also, if we draw *BF* a tangent to the arc at the point *B*, and from the point *E* demit the line *EF* upon it, to form a right angle at *F*, in which case the line *FE* will be parallel to the line *CB*, *BE* will represent the force of gravity, which, by the resolution of forces, is equivalent to *BF* and *FE*; but *FE* is perpendicular to the tangent, or is in the direction *CB* of the radius, and therefore can neither accelerate nor retard the motion, whilst *BF*, being in the direction of the tangent, or perpendicular to the radius, is wholly employed in accelerating or retarding the pendulum's motion: hence, the line  $BE : BF ::$  the force of gravity : the accelerating force; but from the similar triangles *BEF*, *CBA*,  $BF = CB$ , and  $BF = BA$ , therefore, by substitution,  $CB : BA ::$  force of gravity : accelerating force, and consequently the accelerating force =  $\frac{\text{gravity} \times BA}{CB}$ ,

in which expression gravity and the radius *CB* are invariable, therefore the accelerating force varies as the sine *BA* of the arc of vibration. From this law of variation of the accelerating force of a body moving in a circular arc, it follows, that the longer arcs require longer times than the shorter arcs in the proportion of  $34 : 29$ , as Huygens has demonstrated; for the sine does not increase so fast as the arc, which it ought to do, to make the vibrations of the same pendulum in different arcs isochronal: if, however, the body could be made to move along the chord or straight line *BD*, instead of the arc *BD*, then the vibrations of different lengths would be isochronal, because two similar bodies will run down each a separate chord of different lengths to the lowest point of the same circle in the same time, namely, in the time that each would take in falling through

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through the whole diameter of the circle, and the acquired velocity of each, at the lowest point, would be in proportion to the length of its chord. But the mechanician has not attempted to make his pendulum vibrate in chord lines, which probably is impracticable, but has invented another curve, called the cycloid, generated by a point in a circle revolving on a straight line, which curve possesses this peculiar property, that the accelerating forces, which a body acquires by moving along it, are exactly proportionable to the arcs, (see CYCLOID,) so that a pendulum vibrating in this kind of curve, will perform its long and short vibrations in the same time. This property of the cycloid was first discovered by the celebrated Huygens, who owed much of his celebrity to it, and adopted a contrivance for making a pendulum move in such a curve, which will be described under our article PENDULUM, and also the reasons will be given why it was laid aside in the practice of clock-making. It may be proper, however, to remark here, that with a pendulum vibrating in the arc of a cycloid, with all its weight collected in the ball, and its length rendered invariable, if such a pendulum could be made, it would, notwithstanding, be of consequence what the nature of the escapement were, because though the variations in the arcs, arising from varied gravity alone, would not affect the times of the successive vibrations, yet, when additional force is applied in aid of gravity, by means of the maintaining power and escapement, the uniform law of acceleration just described would be partially disturbed by such addition, though the disturbance would be less perceptible than in circular arcs of considerable extent.

When, however, a pendulum vibrates in a small arc, it is demonstrable that such an arc differs very little from a cycloidal arc near its lowest point, nay almost coincides with it; it is also found from experience, that a heavy ball is less disturbed by the requisite additional force, communicated by the maintaining power, than a light one, as might be inferred from theory; on which two accounts the prevailing practice among clock-makers is, to make such escapements for a pendulum as require but short vibrations, and, in order to gain momentum, to append a heavy ball; and it has been discovered, and is now indeed an acknowledged fact, that a regulator with an exact compensation for the effects of variable temperature in its pendulum, and that vibrates by means of a good escapement in small arcs, with a heavy lenticular ball, goes with a degree of accuracy beyond what Huygens durst even hope for from his cycloidal contrivance; in effecting which, theory and practice were found to be greatly at variance.

But the cycloidal theory, which, considered as a theory, is not only ingenious, but illustrative of the principal circumstances which relate to the motion of a pendulum, will furnish us with a concise and clear notion how the natural arc and time of a vibration will be altered by an accession of external force to the force of gravity, without some knowledge of which alteration no mechanician can proceed on scientific principles in the construction of an escapement.

Supposing now the pendulum in *fig. 2*, similar to that in the preceding figure, and the arc to be so small as nearly to coincide with the cycloidal curve, let the arc  $GB$  be unbent into the straight line  $bH$ , and with the semi-arc  $DH$ , as a radius, describe the semi-circle  $HLb$ ; set the line  $AB$  from  $H$  to  $M$ , and from  $b$  to  $m$  perpendicular to the line  $bH$ , and join  $mM$ , which line will pass through the centre  $D$ ; from any other points  $I$  and  $K$  in the semi-arc or radius, draw the lines  $IN$  and  $KO$  parallel to  $HM$ , and also the corresponding ones  $in$  and  $ko$  parallel to  $bm$ ,

and we shall obtain the following relations of the properties of the pendulum's motion, *viz.*

1st. The forces of gravity urging the pendulum towards  $D$  from  $B$ , at the points  $I$  and  $K$  of the semi-vibration, will be represented by, and proportional to, the ordinates  $IN$  and  $KO$  of the straight line  $M D m$ ; and the corresponding ordinates  $in$  and  $ko$  will represent, and be proportional to, the retarding forces of the same gravity, at the points  $i$  and  $k$  of the other semi-vibration, and *vice versa* in each half of the returning vibration.

2dly. The velocities acquired by the uniform action of gravity at the points  $I K$  and  $ik$ , will be respectively proportional to the ordinates  $IP$ ,  $KQ$ , and  $ip$ ,  $kq$ , of the semi-circle  $HLb$ ; hence the velocity of the pendulum at the lowest point  $D$ , is to its velocity at any other point of the arc  $I$ , as  $DL$  ( $= DH$ , or whole semi-arc) is to  $IP$ .

3dly. The times of the pendulums vibrating through the portions  $HI$ ,  $IK$ ,  $KD$ , &c. of its arc, will be represented by, and proportional to their corresponding arcs  $HP$ ,  $PQ$ ,  $QL$ , &c. respectively in the semi-circle  $HLb$ ; which proportions will be equally applicable in the ascending portions of the arc  $Dk$ ,  $ki$ , and  $ib$ , which will also be moved through in times proportional to the arcs  $Lq$ ,  $qp$ , and  $pb$ , respectively; if the pendulum is projected from the lowest point  $D$  with the initial velocity  $DL$ , this velocity will be reduced at the point  $k$  to  $kq$ , at  $i$  to  $ip$ , and at  $b$  to nothing, whence the pendulum will return, and the operation of gravity will begin to be reversed.

4thly. If one pendulum describe the arc represented by  $HDb$ , and another describe the arc  $KDk$ , (still supposing them to be cycloidal or very nearly so,) they will describe them in equal times, but their velocities at  $D$ , or greatest velocities, will be respectively proportional to  $HD$  and  $KD$ , or length of their semi-arcs; that is, while a pendulum, projected with the initial velocity  $DL$ , from the lowest point, ascends to the point  $b$ , or extremity of its semi-vibration, another similar pendulum, projected with the initial velocity  $RD$ , will ascend to the point  $k$ , or extremity of its arc,  $DR$  being  $= DK$ , and the same will be true in the descent, where the increments of motion exactly balance the ascending decrements.

5thly. The areas  $MHIN$ ,  $MHKO$ , &c. are proportional to the squares of the velocities acquired in moving down the arcs  $HI$ ,  $HK$ , &c. or to the diminution of the squares of the velocities effected by the retardation of gravity in the returning or ascending semi-vibration.

From a due examination of the relations exhibited in the preceding illustration of the principles of a pendulum's motion, the reader will readily perceive that there is a certain length of the arc of every vibration, whether performed in a circle or cycloidal curve, which corresponds to its maximum of velocity, or velocity at the lowest point; which length, in large circular arcs, is determined by the greatest chord line, but in cycloidal curves, or small circular arcs, is the whole arc itself: he will also understand how, when the weight of a pendulum is given, its accelerating action in any given point of the arc may be appreciated; from which and similar considerations he will be able to form something like an estimate of the effect that will be produced in the above natural relations by the application of an external force of an ascertained quantity, acting in a given manner: for instance, let us suppose that a maintaining power is applied to keep up the vibrations of a pendulum, as in our last figure; that the quantum of power to be added to gravity be to its accelerating force at  $H$  or  $b$ , as  $hm$  is to  $mr$ , which we will suppose to be a number of grains to some number of ounces; and that this additional power

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power is applied through the agency of an escapement, which so modifies it, that its action is exerted but a short time, and at the extremity of the arc: the rough conjecture which the reader would be apt to form would be, that as the two forces began to act in concert, a pendulum actuated by them would obey a compound scale of forces, differing in quantity but not in quality from the simple scale of gravity, and that therefore little or no alteration would take place in the time of its vibration; let us see what would be the result according to our theory; from the point  $m$  of the line  $bm$ , of the greatell acceleration or retardation, as the case may be, fet off  $mr$  equal to its representative, for so many grains of augmenting or retarding force, and then  $br$  will be the whole force urging the pendulum towards  $D$ : do the same for every point of  $bD$ , and we get a new scale of forces represented by the dotted line  $rstD$ , and the space  $mDr$ , contained between the two scales  $Dm$  and  $Dr$ , will represent the addition made to the square of the velocity in moving over  $bD$  by the joint action of gravity and of the maintaining power. Then if we make the area  $Duv$  equal to the area  $Dhm$ , by leaving out as much space parallel to the perpendicular  $bm$ , as we take in beyond the hypotenuse  $mD$ , the point  $u$  will limit the excursion or extent of the returning, as well as of every succeeding vibration, because the area of the triangle  $Duv$  is proportional to the square of the velocity, and  $u$  is therefore the point where the initial velocity  $DL$  will be extinguished. Lastly, if the arc  $bw$  of the semi-circle be bisected, its half will very nearly represent the contraction effected in the time of the outward semi-vibration, agreeably both to theory and practice; and in a similar manner might be estimated the effect to be produced on a natural vibration, or vibration from simple gravity, by any accession of external force differently applied: in the instance we have given, a temporary impulsion would evidently make a greater derangement when given at the extremity of the arc, than if it had been given at  $I$ , and greater at  $I$  than at  $K$ , and consequently the least derangement would have arisen if the impulsion had been given at the lowest point  $D$ , which is worthy of recollection; though the fact is, that most of the escapements, that are not of the detached kind, continue to act for a sensible time, and, after all, the thing principally aimed at in modern practice is, to construct all the parts of an horological machine so, that the arc of vibration may vary as little as possible under the different influences that affect the pendulum's motion; for then, whatever the length of the arc be, whilst there is no variation in it, the vibrations will be isochronal, whatever be the nature of the curve; but completely to effect so desirable a purpose can hardly be expected under all the combinations of variable resistances arising from friction, oil, air, &c., however detached the escapements may be, *i.e.* however small the continuance of each of their impulsions. Hence, certain ingenious artists have attempted such a compound scale of forces, consisting of gravity and maintaining power conjointly, as shall render even circular vibrations of different lengths isochronal among themselves, when they shall happen to vary in length, which plan would certainly make the best compensation for the effects of variable resistances, if such plan could be completely executed at pleasure; and the compound scale of forces to do this, must be to the scale of gravity alone, as the arc of semi-vibration is to the sine of the same in every point of the excursions. For in *fig. 1*, if  $BF$  be supposed equal to the semi-arc  $BD$ , then  $BE$ , the whole compound force at the point  $B$ , will be greater than  $CB$  or force of gravity alone, and will be to it, by similar triangles, as  $BF (= BD)$ , is to the sine

$AB$ , as has been demonstrated; therefore the whole compound force at any point  $B$  of either semi-vibration should be to the force of gravity alone in that point, as the arc  $DB$  is to the sine  $AB$ , which compound scale consequently will demand a certain limited variation, or scale, in the auxiliary force derived from the maintaining power through the modifying medium of the escapement.

2. When a balance was first applied as a regulating power, it possessed no natural property, like the pendulum, of perpetuating its own oscillations, but had its motion produced by an artificial force acting alternately on its opposite pallets, and derived entirely from the maintaining power at certain intervals; so that to perform all the oscillations in equal times, the action of the force applied was required to be the same in mode, quantity, and duration, in each oscillation, which conditions could not be fulfilled by reason of the constant changes that took place in the friction of the works, and in the density and consequent resistance of the air; a simple balance therefore was no otherwise better than a continued fly, except that its alternate oscillations prevented the acceleration of motion that would ensue, if there were no such frequent checks as the balance experiences at each alternate impulse of the pallets. Dr. Hooke's invention of a regulating spring, to be to the natural balance what gravity is to a pendulum, was an important one, to which all the excellence of an ordinary watch may have its origin imputed, and without which the compensations for different temperatures in the best chronometers would not be of any utility. The discovery of a *spring's force* being *as its tension*, or distance moved from the point of rest, (*ut tensio sic vis*,) was the first step towards a theory of motion by which the balance and its regulating spring, taken conjointly, may have their effect estimated, and by which such a balance with the best compensation and escapement now vies in accuracy even with the pendulum itself.—George Atwood, esq. of Cambridge, has published an excellent memoir in the Philosophical Transactions of London, vol. 84, part i. 1794, intitled "Investigations founded on the Theory of motion, for determining the times of Vibration of Watch Balances," from which we beg leave to extract so much as falls within our purpose in this place.

"Let  $PMNS$ , *fig. 3*. of our last plate, represent the circumference of a watch balance, which vibrates by the action of a spiral (or helical) spring, on an axis passing through the centre  $C$ . Let  $ODBE$  be the circumference of a concentric circle, considered as fixed, to which the motion of the balance may be referred. In the circumference of this circle let any point  $O$  be assumed, and when the balance is in its quiescent position, suppose a line to be drawn through  $C$  and  $O$ , intersecting the circumference of the balance in the point  $A$ ; the radius  $CA$  will be an index, by which the position of the balance, and its motion through any different arcs of vibration, will be truly defined. In the sequel, the motion of the balance, and the motion of the index  $CA$ , will be used indifferently, as terms conveying the same meaning. Since the balance is in its quiescent position when the index  $CA$  is directed to the fixed point  $O$ , on this account  $O$  is called the point of quiescence of the balance, or balance spring, indicating the position when the balance is not impelled by the spring's elastic force either in one direction or the other. If the balance should be turned through any angle  $OCB$ , the spiral spring being wound through the same angle, endeavours by its elastic force to restore itself, and when at liberty, impels the balance through the arc  $BO$  with an accelerated velocity, till it arrives at the position  $O$ , where the force of acceleration ceases; with the velocity,

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city acquired at O, the balance proceeds in its vibration, describing the arc OE with a retarded motion. The elastic forces of the spring at equal distances, on the opposite sides of the point O, are assumed to be equal; it is also assumed that the effects of friction, and other irregular resistances, which retard the motion of the balance, are compensated by the maintaining power, so that the time of describing the first arc of vibration BO, by an accelerated motion, shall be equal to the time of describing the latter arc OE, by a retarded motion, and that the entire arc of vibration BOE is bisected by the point O.

To render the construction of *fig. 3.* more distinct, the fixed circle ODBE is represented to be at a small distance from the circumference of the balance, but is to be considered as coincident with it, so that the arc BO, subtending the angle BCO, may be of the same length with an arc of the circumference of the balance, which subtends the same angle BCO: on this principle CO or CA may be taken indifferently as the radius of the balance.

The determination of the time in which the balance vibrates, from the theory of motion, requires the following particulars to be known, *viz.*

First. The spring's elastic force, which impels the circumference of the balance, when it is at a given angular distance OD, (*fig. 3.*) from the quiescent point O:

Secondly. The law or ratio observed in the variation of the spring's force, while the balance is impelled from the extremity of the semi-arc B, to the point of quiescence O, where all acceleration ceases.

Thirdly. The weight of the balance, including the parts which vibrate with it.

Fourthly. The radius of the balance CO, and the distance of the centre of gyration from the axis of motion CG.

Fifthly. The length of the semi-arc BO.

Suppose the plane of the balance to be placed vertically, and let a weight P, (*fig. 4.*) be applied by means of a line suspended freely from the circumference at T, to counterpoise the elastic force of the spring when the balance is wound through an angle from quiescence OCD. This weight P (the weight of the line being allowed for,) will be the force of the spiral (or other) spring, which impels the circumference of the balance, either at rest or in motion, when at the angular distance OD from the quiescent position. It appears from many experiments (of Berthoud) that the weights necessary to counterpoise a small spring's elastic force, when the balance is wound to the several distances from the quiescent point, represented by the arcs OG, OH, OI, &c. *fig. 4.* are nearly in the ratio of those several arcs. It also appears, that the shape, the length, and number of turns of the spiral, may be so adjusted to each other, that the forces of elasticity shall be counterpoised by weights, which are in the precise ratio of the angular distances from the quiescent position, or, as it is sometimes expressed, in the ratio of the spring's tensions; at least as nearly as can be ascertained by experiment: this law of elastic force is assumed in the subsequent investigation.

The position of the centre of gyration may be always determined when the figure of the vibrating body is regular, by calculating the sum of the products, which arise from multiplying each particle into the square of its distance from the axis of motion, and dividing the sum by the weight of the vibrating body; the square root of the result will be the distance of the centre of gyration from the axis of motion. When the figure of a vibrating body is irregular, recourse must be had to experimental methods, in order to

determine the position of the centre of gyration. See Atwood's treatise "On the Rectilinear Motion and Rotation of Bodies."

Let the radius of the balance CA or CO =  $r$ , *fig. 3.* the semi-arc BO =  $b$ ; let the spring's elastic force, acting on the circumference of the balance, when wound to any given angle OCD, from the quiescent position, be P, and let the arc OD =  $a$ ; the weight of the balance and the parts which vibrate with it =  $W$ ; the distance of the centre of gyration from the axis of motion CG =  $g$ . These notations being premised, the resistance of inertia, by which the mass contained in the balance opposes the communication of motion to the circumference, is  $\frac{Wg^2}{r^2}$ ,

and consequently the force which accelerates the circumference at the angular distance OCD from the quiescent position is  $\frac{Pr^2}{Wg}$ . This quantity remaining invariably the same, while the balance describes the arc of vibration BOE, may be denoted by the letter F, so that  $F = \frac{Pr^2}{Wg}$ ; suppose

the radius CA commencing a vibration from the point B to have described the arc BH, and let OH =  $x$ , since the force which accelerates the circumference at the angular distance from quiescence OD = F, and the forces of acceleration are supposed to vary in the proportion of the angular distances from the quiescent point O, the force which accelerates the circumference of the balance at the point

H will be =  $\frac{Fx}{a}$ ; let  $u$  be the space through which a body

falls freely from rest by the acceleration of gravity, to acquire the velocity of the circumference at the point H; the principles of acceleration give this equation  $u =$

$\frac{-Fx\dot{x}}{a}$ ; (Newtonii Princip. vol. i. prop. xxxix.) and

taking the fluents while  $x$  decreases from  $b$  to  $x$ ,  $u = \frac{F \times b - x^2}{2a}$ ; if therefore  $l$  is made = 193 inches, being the

space which bodies falling freely from rest by the force of gravity near the earth's surface describe in one second of time, the velocity of the circumference, when the extremity A of the index CA has arrived at the point H,

will be =  $\sqrt{\frac{2lF}{a} \times \sqrt{b^2 - x^2}}$ . Let  $t$  represent the time in which the circumference describes the arc BH; then

will  $t = \sqrt{\frac{a}{2lF} \times \frac{-\dot{x}}{\sqrt{b^2 - x^2}}}$ ; and  $t = \sqrt{\frac{a}{2lF} \times a}$

circular arc, of which the cosine =  $\frac{x}{b}$  to radius = 1, which

is the time of describing the arc BH expressed in parts of a second; when  $x = 0$ , that is, when the circumference has described the entire semi-arc BO, the circular arc of which

the cosine =  $\frac{x}{b}$  is a quadrant of a circle to radius = 1. Let

$p = 3.14159$ , &c. the time  $t$  of describing the semi-arc

BO =  $\sqrt{\frac{a}{2lF} \times \frac{p}{2}} = \sqrt{\frac{p^2 a}{8lF}}$ .

In this expression for the time of a semi-vibration, the letter  $a$  denotes the length of the arc OD (*fig. 3.*); if this arc should be expressed by a number of degrees  $c^\circ$ ,  $a$

will then =  $\frac{prc^\circ}{180}$ ; and this quantity being substituted for

$a$ , the

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$t$ , the time of a semi-vibration will be  $t = \sqrt{\frac{p' r c^2}{8 l F \times 180^2}}$ ;

if instead of  $F$ , its value  $\frac{P r^2}{W g}$  is substituted in the equa-

tion  $t = \sqrt{\frac{p r c}{8 l F \times 180}}$ , the time of a semi-vibration will

be  $t = \sqrt{\frac{W p g^2 c}{8 P r l \times 180^2}}$ .

Let the given arc  $c'$  be  $= 90$ ; in this case  $t = \sqrt{\frac{W p g^2 c^2}{16 P r l}}$ .

These are expressions for the time of a semi-vibration, whatever may be the figure of the balance, the other conditions remaining the same as they have been above stated. If the balance should be a cylindrical plate, it is known that the distance of the centre of gyration from the axis is to the radius as 1 to  $\sqrt{2}$ ; wherefore in this case  $g^2 = \frac{c^2}{2}$ ; and the time of a semi-vibration, or  $t = \sqrt{\frac{W p^2 r}{32 P l}}$ .

Agreeably to this expression, Mr. Atwood wished to try the practical results of a chronometer made by Kendal, to prove how far his theory agrees with practice, and assuming the centre of gyration to be the same as if the balance were a cylindrical plate, he obtained from Mr. Earnshaw the following data, *viz.*

- $W$ , the weight of the balance and vibrating parts = 42 grains.
  - $P$ , the force at the circumference of the balance, which counterpoises the force of the spring when wound to the distance of  $90^\circ = 24$  grains.
  - $r$ , the radius of the balance = 1.125 inches.
  - $l$ , the space described in one second of time by bodies which descend freely from rest by the acceleration of gravity = 193 inches.
  - $p$ , the circumference of a circle to radius 1 = 3.14159, &c.
- The balance, when adjusted to mean time, made just five vibrations in a second; the actual time of a semi-vibration is therefore 0.1000.

Then  $t$ , the time of a semi-vibration by the theory, will be  $= \sqrt{\frac{42 \times 3.14159^2 \times 1.125}{32 \times 24 \times 193}} = 0.0994$  parts of a second; hence  $0.1000 - 0.0994 = 0.0006$  is the difference between the actual time and the time by calculation from the theory; and the near coincidence of the two results proves that the supposition of the centre of gyration being nearly as in a cylindrical plate, is near the truth.

"It is observable," says our author, "that the semi-arc of vibration  $BO = b$ , does not enter into these expressions for the time of a semi-vibration; if, therefore, instead of the semi-arc  $BO$ , an arc of any other length  $LO$ , terminating in the point of quiescence, (*fig. 3.*) should be substituted in the preceding investigation, the time of describing  $LO$  would be

still  $= \sqrt{\frac{a p^2}{8 l F}}$ , or,  $\sqrt{\frac{p' r c^2}{8 l F \times 180^2}}$ , equal to the time

of describing the other semi-arc  $BO$ ; consequently, whether the balance vibrates in the largest or smallest arcs, the times of vibration will be the same. From the preceding investigations it appears, continues our author, that when the force by which the circumference of the balance is accelerated at the given angular distance  $c^\circ$  from the quiescent position is  $= F$ , the time of a semi-vibration  $t =$

$\sqrt{\frac{p' r c^2}{8 l F \times 180^2}}$ ; and conversely, when the time of a semi-

vibration is  $= t$ , the force which accelerates the circumference at the given angular distance  $c^\circ$  from the quiescent

position, that is,  $F = \sqrt{\frac{p' r c^2}{8 l t^2 \times 180^2}}$ .

"Since time-keepers are usually adjusted to mean time when the balance makes five vibrations in a second, the time of a semi-vibration will, in this case, be  $= \frac{1}{10}$ th part of a second; the substitution of  $\frac{1}{10}$ th for  $t$  being made in the preceding equation, the force which accelerates the circumference of the balance, when at any given angular distance  $c^\circ$  from the quiescent position, will be determined for all time-keepers adjusted to mean time, in which the balances make five vibrations in a second. Suppose the given angle  $c^\circ = 90^\circ$ , then making  $c^\circ = 90^\circ$ ,  $p = 3.14159$ , &c.  $l = 193$ ,  $t = \frac{1}{10}$ , the accelerative force at the angular distance from quiescence

$90^\circ$  or  $F = \frac{p' r 90^2}{8 l t^2 \times 180^2} = r \times 1.00408926$ . We have

therefore arrived at the following conclusion; if the radius of the balance is equal to one inch, and the time-keeper is adjusted to mean time when the balance makes just five vibrations in a second, the force which accelerates the circumference of the balance at the distance of  $90^\circ$  from the quiescent position is  $= 1.00408926$ , the accelerative force of gravity being  $= 1$ . And if the radius of the balance is greater or less than one inch, the force by which the circumference is accelerated at the distance of  $90^\circ$  from quiescence will be greater or less than 1.00408926 in proportion to the radii.

"According to the principles assumed in the preceding solution, the spring's elastic force is supposed to vary in the proportion of the angular distances from the quiescent position, and on this condition the vibrations are shewn to be isochronous, whether they are performed in longer or shorter arcs; but if the spring's elastic force at different distances from quiescence should not be precisely in the ratio here assumed, the longer and shorter arcs may be described in times differing in any proportions of inequality. If, for instance, the spring's force, instead of varying in the ratio of the aforesaid distances, should vary in the  $\frac{1}{1000}$ th power or  $\frac{1}{800}$ th power of the distances, it does not appear from the preceding solution what alteration in the daily rate would be caused by this change in the law of the force's variation, when the semi-arc of vibration is increased or diminished by a given arc. To ascertain this point fully, other researches will be necessary, by which it may be known, what alteration of the daily rate of a time-keeper is occasioned by a given increase or diminution of the arc of vibration, when the spring's elastic force varies in a ratio of the distances from the quiescent position, the general index or exponent of which is any number or fraction  $n$ .

"The force which accelerates the balance being assumed in that power of the distances, the exponent of which is  $n$ , let  $BO = b$ , (*fig. 5.*) be the semi-arc of vibration when the time-keeper is adjusted to mean time; let  $DO = a$ ; the accelerating force on the circumference at the distance from quiescence  $OD = F$ ; suppose the circumference to have described the arc  $BH$  from the extremity of the arc  $B$ ; and let  $HO = x$ : then the force by which the circumference is accelerated when at the angular distance from

the quiescent position  $OH = \frac{F x^n}{a^n}$ ; let  $u$  be the space

through which a body falls freely from rest by the acceleration of gravity, to acquire the velocity of the circumference when it has described the arc  $BH$ : the principles of acceleration gave this equation  $u = \frac{-F x^n \dot{x}}{a^n}$ : taking the flu-

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ents while  $x$  decreases from  $b$  to  $a$ ,  $u = \frac{Fl^{n+1} - Fa^{n+1}}{n+1 \times a^n}$ , and  $l$  being 193 inches, the velocity acquired by the circumference, after describing BH; will be  $= \sqrt{\frac{4lF}{n+1 \times a^n}} \times$

$\sqrt{b^{n+1} - a^{n+1}}$ ; let  $T$  be the time of describing the arc BH; wherefore  $T = \sqrt{\frac{n+1 \times a^n}{4lF}} \times \frac{-\dot{x}}{\sqrt{b^{n+1} - a^{n+1}}}$ .

The time of describing the arc BH will be the fluent of this fluxion, while  $x$  decreases from  $b$  to  $a$ , and the time of describing the semi-arc BO will be the entire fluent of

$\sqrt{\frac{n+1 \times a^n}{4lF}} \times \frac{-\dot{x}}{\sqrt{b^{n+1} - a^{n+1}}}$ , while  $x$  decreases

from  $b$  to  $a$ . Now let the balance commence its vibration from any other point I, (fig. 5.) and let IO =  $c$ ; suppose the circumference to have described the arc IK, and make OK =  $y$ ; let  $t$  be the time of describing the arc IK; then by proceeding in the same manner as in the former case, it is

found that  $t = \sqrt{\frac{n+1 \times a^n}{4lF}} \times \frac{-\dot{y}}{\sqrt{c^{n+1} - y^{n+1}}}$ ; and

the time of describing the semi arc IO will be the entire fluent of this fluxion, while  $y$  decreases from  $c$  to  $a$ . Al-

though the fluents of the fluxions  $\frac{-\dot{x}}{\sqrt{b^{n+1} - a^{n+1}}}$ , and

$\frac{-\dot{y}}{\sqrt{c^{n+1} - y^{n+1}}}$ , cannot be expressed in general terms,

yet the exact proportion of the said fluents may be assigned, which will be the proportion of the times in which the balance vibrates in the two semi-arcs BO, IO; the multiply-

ing quantity  $\sqrt{\frac{n+1 \times a^n}{4lF}}$  being common to both fluxions;

and since the entire fluent of  $\frac{-\dot{x}}{\sqrt{b^{n+1} - a^{n+1}}}$  is to the en-

tire fluent of  $\frac{-\dot{y}}{\sqrt{c^{n+1} - y^{n+1}}}$  as  $b \frac{1-n}{2}$  is to  $c \frac{1-n}{2}$ ,

it follows that the time of a semi-vibration in the arc BO is to the time of a semi-vibration in the arc IO

as  $b \frac{1-n}{2}$  to  $c \frac{1-n}{2}$ , or as 1 to  $\frac{IO}{BO} \frac{1-n}{2}$ .

Suppose a watch to be adjusted to mean time when the semi-arc of the balance's vibration is = BO, (fig. 5.) and let this semi-arc be afterwards diminished to IO; the time shewn by the watch in any given portion of mean time  $t$ , when the semi-arc of vibration is IO, will be  $= t \times \frac{BO}{IO} \frac{1-n}{2}$ ; and if  $t$  is put =  $24^h$ , the alteration of the

daily rate, in consequence of the diminution of the semi-arc of vibration from BO to IO, will be  $24^h \times \frac{BO}{IO} \frac{1-n}{2} - 1$ .

To apply this proposition, let a case be assumed; suppose a watch to be regulated to mean time, when the semi-arc of vibration is  $135^\circ$ , and let this semi-arc be diminished  $8^\circ$ , so as to become  $127^\circ$ ; let the ratio of the spring's elastic force deviate from that of the distances from the quiescent position by a small difference of  $\frac{1}{10000}$ th power of the distances, instead of in the entire ratio of the said distances from the quiescent position. The alteration in the daily rate of the

watch will be obtained from the preceding theorem, by making the following substitutions; BO =  $135^\circ$ ; IO =  $127^\circ$ ,  $n = 10000$ , the alteration of the daily rate =  $24^h \times \frac{135}{127} \frac{1}{10000} - 1 = + 2''.62$ ."

From this theory of the balance and balance spring it is evident, that when there is a very minute alteration in the law of the force's variation, amounting to no more than  $\frac{1}{10000}$ th part of the entire ratio of the distances, an acceleration is caused in the daily rate of more than  $2\frac{1}{2}''$ , when the diminution of the semi-arc is only  $8^\circ$ , and as this alteration in the force is less, probably, than can be detected by actual measurement of the force by mechanical means, it is very probable that a much greater acceleration or retardation of the rate, than in the example before us, may occur from the same cause, which can only be corrected by a corresponding alteration either in the length or strength of the balance spring, or both, as the case may require, and the best way of detecting the law of force by which the spring acts at different distances from the quiescent position, is by increasing or diminishing the maintaining power, so as to render the arc of vibration unequal in successive trials for a limited time. The necessary conclusion, from such trials with different maintaining powers, will be, that when an acceleration of the daily rate accompanies a diminution of the arc of vibration, the elastic force of the spring used varies in a less ratio than that of the distances from the quiescent position; but on the contrary, when a retardation takes place under the same circumstances, the said elastic force varies in a higher ratio than that of the distances from the point of quiescence. We here suppose the same escapement to be used in all the trials, and that the impulse given to the balance is no more than sufficient to overcome the inertia of the balance and the resistance it meets with from friction and the density of the air; but as there is generally an overplus of power communicated to the balance to guard against stopping by the accession of dirt or thickening of the oil, this superfluous power has such an influence on the balance and its spring when in motion, as to produce a compound law of varying forces, somewhat different from the simple law derived solely from the elasticity of the spring, and the more this compound law varies from the simple law derived from the spring's elasticity, the greater will be the discrepancy between the theory and performance of a watch balance. The business of a good escapement of a watch or balance clock is to keep the balance in continual motion with as little interference as possible with the simple law of its natural varying forces, which it has been shewn are in proportion to the distances from the point of quiescence.

After these remarks on the laws by which a pendulum and a balance together with its spring become the regulators of an horological machine, the reader will be able to form an opinion, founded on scientific principles, on the merits or demerits of the different escapements that are successively described, not only in this article, but in the articles CHRONOMETER and CLOCK, which have been already published.

Henry Sully, who was an ingenious clock and watch maker about the beginning of the 18th century, wrote a history of the escapements of his time down to the year 1727, which Julien le Roy added to Sully's "Regle Artificielle du Temps," in the second edition, published at Paris, 1737, from which Berthoud has extracted his account of several escapements in his "Histoire de la Mesure du Temps," and which we mean to avail ourselves of in a certain degree in our subjoined descriptions.

## ESCAPEMENT.

The different escapements of clocks and watches may be divided into four classes; *viz*;

1. Those with a *recoil*; or which produce a backward motion of the escapement wheel and second's hand in some parts of the vibration; (échappement a recul.)

2dly. Those that have the *dead-beat*, or that allow the escapement wheel and hand to rest while the whole vibration is made; (échappement a repos.)

3dly. *Detached*, or *free* escapements, which act on the balance or pendulum an almost insensible time, and suffer the vibration to be performed almost without connection with the pallets; (échappement a vibrations libres.)

4thly. *Detached*, or *free* escapements with a *remontoir*, or auxiliary spring frequently wound up by the maintaining power, to equalise the arcs of vibration; (échappement a vibrations libres et a remontoir d'égalité d'arcs.)

The most ancient escapement in use at this time, and probably the first that was ever contrived, is the *crown-wheel escapement* at present employed in our table-clocks and common watches; we know not who was the original inventor, but find mention made of it by Leonard de Vinci, who died in the year 1513; and Venturi thinks that the horological machines of Wallingford and Dondi, early in the fourteenth century, had the same, as we have seen, under our article *CLOCK*, that Henry de Wyck's clock had in the year 1364. The idea of converting a rotatory into a vibratory motion, and the means adapted to effect this purpose mechanically are equally ingenious; as an effort of genius this thought is much to be admired. We have already given a general description of the connection that the escapement-wheel has with a train of wheel-work on one side of it, and with the balance on the other, under our article just referred to, but as the balance had no rim, and was without the *regulating*, or, as it is sometimes called, the *pendulum spring*, we think it right to give a separate drawing and description of this escapement, as made at present, together with some remarks on its properties.

1. *Crown-wheel escapement*.—In *Plate XXXI. of Horology*, *fig. 6.* represents the crown-wheel and balance in connection, which may be in either a horizontal or vertical position, and is in fact sometimes in one position and sometimes in the other in a common watch agreeably to the different positions of the body of the wearer; and it is easy to conceive that a short pendulum might be substituted for the balance when the crown-wheel moves horizontally in a fixed position, and the axis of the balance is placed horizontally, which is the case in most of the portable clocks. The name of crown-wheel is taken, no doubt, from the resemblance it has to an old fashioned *royal diadem*; but when applied to a watch it is frequently called simply the *balance-wheel*, from its connection with the *balance*: this wheel and the balance, including the pallets and regulating spring, may be considered as constituting the *escapement*, the action of all which may be understood from the following short account.

Suppose the pinion *a*, on the arbor *ab* of the balance-wheel or crown wheel *cd*, to be actuated by the main-spring, or weight which forms the maintaining power, by means of the ratchet, in the direction *efdc*, while the pallets *e* and *f*, attached to the axis of the balance *gb*, and standing at right angles to each other, or very nearly so, are long enough to all in the way of the ends of the sloped teeth of the wheel, when turned round an angle of 45°, so as to point in opposite directions, as in the figure; then a tooth of the wheel below, for instance, meets with the pallet *f*, supposed to be at rest, and drives it before it a certain space, till the end

of the tooth *escapes*; in the mean time the balance attached to the axis of the pallets moves in the direction *blg*, and winds up the small spiral spring *i*, one end of which is fast to the axis and the other to a stud on the plate of the frame, in this operation the spring opposes the momentum given to the balance by this push of the pallet *f*, and prevents the balance from going quite round before the pallet *e* meets with another tooth at the opposite end of the wheel's diameter; here this pallet receives a push which carries the balance back again, having as yet but small momentum, in the direction *blg*, and aids the spring, which now unbends itself till it comes to its quiescent position, but beyond that point is unwound, partly by the push from the maintaining power on the pallet *e*, and partly by the acquired momentum of the moving balance, particularly when this pallet has escaped; at length pallet *f* again meets with the succeeding tooth, and is carried *backward* by it, in the direction the balance is now moving in, till the maintaining power and force of the unwound spring together overcome the momentum of the balance; during which time the *recoil* of the second's hand is apparent, when put on the pivot of the arbor *ab*; at length the wheel brings the pallet *f* back again till it escapes, and the same process takes place with pallet *e* that has been described with respect to pallet *f*, and thus two contrary excursions, or oscillations of the balance, take place before one tooth has completely escaped, which is the reason why there must be always an odd number of teeth in this wheel, that a space at one side of the wheel may always be opposite to a tooth at the other, in order that one pallet may be out of action while the other is in action. The same account will apply to the vibrations of a short pendulum substituted for the balance, when this escapement is used. This escapement, which is of the first class, is evidently calculated to derange the natural law of the spring's varying force, which, we have seen, is in theory in proportion to the distances from the quiescent position; for as the action of the maintaining power continues to press on the pallets, either with or against the balance's motion, during a large portion of each vibration, this extraneous force acting along with the elastic force of the spring makes a new law compounded of the two forces, which may or may not be a regular law, as modified by circumstances, that are to be taken into consideration; for instance, the relative forces of the maintaining power and of the regulating spring, the uniformity of each force separately considered, the ratio between the radius of the pallet-wheel and length of the pallets, the weight and diameter of the balance, the angle of action in the escapement relatively to the whole arc of vibration, the adjustment of the length and strength of the spring for isochronism, and of its quiescent place to the position of the pallets, together with the friction and inertia of the acting parts, as well as resistance of the air to the moving balance must all enter into the account, which complex data render all calculations founded in theory very inadequate to their purpose of determining the practical results independently of experimental trials, which are necessarily adopted by the workmen in finishing the adjustments. The bad effect of an almost constant force on the balance, as derived from the maintaining power, is evident by the application of the key to the fusee-arbor of a watch, and by urging it in a direction contrary to that of winding up, for the additional force thus given to the maintaining power, will very sensibly accelerate the beats of the watch, and lessen the arc of vibration; hence any inequality occasioned in the maintaining power, by the accession of dirt, or by want of perfect compensation in the fusee of the varying force of the main-spring, &c. will alter the daily rate very materially, though the mechanical

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mechanical adjustments at the balance may, in the first instance, have produced jointly a law of varying forces in the regulating mechanism that shall approximate near enough to the isochronous law of the balance spring, while the arcs of vibration remain unaltered. It is of the utmost importance, therefore, when a crown-wheel escapement is used in any watch, that, whenever a new main-spring is put in, the fusee should also be altered, so as to become as perfect a compensator as possible for that *identical spring*, which, we believe, is seldom, if ever, attended to in practice. This escapement usually has a pin in the rim of the balance that may catch a notch on each side of the cock beyond the extremities of the longest vibrations, called the *banking*, to prevent the derangement of the balance and of its regulating spring by any shake or accident.

2. *Escapement a pirouette by Huygens.*—About the year 1675, when Huygens was contriving the best construction he could devise of a marine time-piece, he naturally dwelt upon the portability of the balance, as affording the likeliest plan of accomplishing his purpose, but he was aware that the balance vibrating in short arcs was not comparable in point of steadiness to a pendulum, as a regulating principle, seeing it is too much under the controul of the maintaining power, when used with the crown-wheel escapement, the only one at that time known. The balance under such strong influence, and that a variable influence, had the property of putting itself into motion when in a state of rest: Huygens, therefore, made such additions to the balance and escapement then in use, as produced much longer vibrations than had been before witnessed, and introduced an additional wheel and pinion between the pallet-wheel and the balance to effect this object; thus, in *fig. 7.* of our last plate, is a side view of a small frame containing the mechanism of Huygens' escapement, consisting of two wheels, one pinion, a pair of pallets, and a balance with the spiral spring, together with the requisite cocks to bear the pivots of the arbors; *a b* is the crown-wheel or pallet-wheel of the usual shape and number of teeth, placed in a vertical position, like the contrate wheel of a common watch or table clock; *c d* is a contrate wheel placed horizontally, like the pallet-wheel of a common watch, having two pallets *e, f*, as usual on its arbor, at right angles to each other, and acting exactly as we have explained above; the contrate wheel *c d* drives a pinion *g* on the axis of the balance *h*, under which, as usual, is the spiral spring *i*; the action of this escapement differs from that of its predecessor only, inasmuch as the contrate wheel impels the pinion several times round at each impulse of one of the pallets, thereby occasioning several revolutions of the balance itself at each oscillation; and Sully says, that when the spring is not used he has seen the oscillations performed in the space of two seconds, and with a spring in one, in imitation of a seconds' pendulum clock, to which this escapement is not applicable. The influence, however, of the maintaining power must have been exerted on the balance in this construction also, during at least one of its revolutions, and the extraneous force interfering with the law of the spring's varying forces would produce a compound scale of forces, in which, as in the former instance, one would be nearly constant while it acted, and the other varying; besides, the friction in the teeth of the wheel and pinion, however well executed of the respective sizes and shapes, would produce checks that would be unfavourable to the steady oscillations of the balance, we therefore are not surpris'd to find that this escapement, which was of the first class, was soon discontinued.

3. *Escapement with two balances by Dr. Hooke, and by Du Tertre.*—Dr. Hooke, says Sully, produced a balance

in the year 1675, which he had invented in 1658, with two balances engaging each other by means of teeth cut in their edges, and one of them having a spiral spring on its verge or axis; but Berthoud attributes the invention of this escapement with two balances, without the spring, to a German artist on the authority of Thiout (*Traité d'Horlogerie de Thiout*) where there is a drawing of the escapement in question; J. B. Du Tertre afterwards made some additions, which we have given in *fig. 8.* of *Plate XXXI.*, and of which the following is a description, *viz.*; *A* and *B* are two balances acting together, like wheels with equal numbers of teeth, and having on one of the crosses of each a pallet, at *a* and *b* respectively; at equal distances from the axes of these balances is the arbor of the last wheel of the train, bearing two stars with each five radii, one numbered 1, 2, 3, &c. which is smaller than the other, lying the lower in position, and the other marked *d e f*, &c. with radii long enough to reach almost to the centres of motion of the balances, which they can pass only when the semi-circular parts that are cut away are presented to them; but at other times they rest against the central semi-circular pieces that remain uncut: the radii of the small star reach far enough to fall on the pallets *a* and *b* successively, which they impel alternately, and give motion to both balances at the same time; but the escape takes place by means of the radii of the large star, that rest successively against the semi-circular portions of metal not cut away, above the centres of the balances respectively. The three axes stand in the angles of an isosceles triangle, and have their upper pivots supported by three separate cocks, placed over the upper plate of the frame, the lower pivots of the balances resting on the upper plate, but the arbor of the two stars passing across the frame to take the last wheel. The action is thus; radius 1 of the small star has parted with the pallet *a* of balance *B*, and the long radius *d* is escaping; presently radius 4 will fall on the pallet *b* of balance *A*, and impel it in a direction from 4 to 5, the balance *B* at the same time moving in a contrary direction; this impulse will continue till the radius 4 falls from the pallet, soon after which the long radius *g* will fall on the semi-circular central piece of balance *A*, and stop the further motion of the two stars, which move together on the same arbor, and the balances will go on in their vibrations till the spring under balance *B* brings them back again, so as to present the cut half of the central piece of balance *A* to the point *g* of the long radius, which, being impelled by the train, now escapes; the stars go on till radius 4 of the small star meets with the pallet *a* of balance *B*, the motion of which it now opposes, and is itself brought back, so as to make a recoil of the hands till it has stopped the motion of the balances, which now begin each another oscillation: this radius 4 escapes the pallet *a*, and the long radius *g* falls on the semi-circular piece, at the centre of balance *B*, as it did before on that of balance *A*; the oscillation continues forward again till the spring brings it back, when another following radius of the small star falls again on the pallet *b* of balance *A*, as before, and drives it; soon after which a succeeding long radius falls on its semi-circular central piece, and rests till the return of the oscillation it can escape; thus an alternation of oscillations is produced by the short radii acting alternately on the two balances, while the long radii suspend the impulses by resting on the semi-circular parts of the centres of the balances, during the latter portion of each excursion. This escapement was evidently of the first class, like its predecessors, and though it avoided the jerk usually given to one balance by the stroke of the pallet, yet was subject to the friction arising from the action of the teeth, like the preceding

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ing one; it had, however, a capability of making the angle of action and angle of the balance's motion before the escape in any ratio to each other, by altering the lengths or number of the radii respectively, as well as the distance of the pallets from the centres of motion; it had also the good property of preventing an increase in the maintaining power from affecting the balances in the same proportion, by the long lever pressing against the semi-circular central part of the balances alternately, during the latter part of the excursion of the balances, so as to check any accession of momentum occasioned by an accession of maintaining power: the law of this pressure, however, might be modified by changing the figure of the semi-circular piece into a spiral shape, so that the pressure might bear a proportion to the angular distances of the balances from the spring's quiescent position. The friction in both cases, it must be admitted, would be detrimental to the performance. The banking, we presume, in this escapement, was the same as in an ordinary watch, as no remark is made thereon. The invention, it appears, must be attributed to three successive artists; first the German, whoever he was, invented the escapement without the balance spring, and with the small star only, in which state it would act under the controul of the main-spring, without the regulating spring: secondly, the regulating spring was added by Dr. Hooke, and, thirdly, the large star was introduced by Jean Baptiste Du Tertre, about the year 1724, which addition completed the escapement as given in our drawing, which in its present state will not act without a regulating spring. Of course this last addition followed Tompion's and De Baufre's escapements hereafter described, from which probably the idea of the large star pressing on the circular part of the axis of motion was derived. Each addition was evidently an improvement on the original German escapement as described by Thiout; but the number of pivots in motion, and the increased friction occasioned by the pressure of the semi-cylindrical pieces at the centres of the balances, were obstacles too powerful to be overcome in this construction.

4. *First dead beat escapement by Tompion.*—The ingenious Tompion of London was probably the first watch-maker who contrived an escapement without recoil, or escapement of the second class, called a *dead-beat* escapement from the circumstance of the second's hand remaining motionless, or, as it were, dead, during the motion of the balance after the escape. Sully says that he succeeded in effecting this about the year 1695. In this escapement, of which *fig. 7. of Plate XXXV.* is a plan, the balance verge carried a cylindrical piece of metal *a b c*, terminating with a pallet *c*, with a notch cut between *a* and *c* to allow the escape of each successive tooth of the balance wheel. This wheel had its plane parallel to the planes of the plates of the frame, and its teeth bent at the end, and so distant, that the cylindrical piece and pallet could revolve between any two of them. When the cylindrical part of the pallet presented its notch to a contiguous tooth of the escapement wheel, it received a push therefrom, which put the balance in motion, and the next succeeding tooth falling on the circular or cylindrical portion of the pallet, now in motion in the direction *c b a*, rested against it without recoil till the balance spring had brought the notch back again, when it escaped in its turn by giving its push, and a third tooth fell on the cylindrical part of the pallet, and in like manner remained motionless till the notch came back again and allowed the escape: thus one escape took place at every alternate vibration, and the contrivance was admirably calculated to prevent the bad effect on the balance of any change in the impulses derived from the main-spring; but the friction on the back of the pallets when large, and at

the balance pivots occasioned by the pressure of the resting teeth, constituted the same objection in practice as applied to Du Tertre's modification of the escapement with two balances. This escapement, however, was the archetype of all the succeeding dead-beat escapements, and therefore is deserving of the notice we have given it.

5. *Cylinder escapement in diamond by De Baufre.*—A native of Geneva of the name of Facio had applied rubies to the pivot holes of a watch about the year 1700, and went into partnership with De Baufre, a French watch-maker, established in London; the latter artist finding the advantage of applying the polished surfaces of the precious stones for diminishing friction at the parts of action, contrived a new escapement about 1724, of which the pallets were of diamond. Sully says that a watch of De Baufre, with the diamond pallets, was put into his hands by sir Isaac Newton, who had found its accuracy of performance admirable. The following account will be intelligible, we presume, to any artist who understands the mechanism of a watch. The balance had two pallets on its verge consisting of a semi-cylindrical diamond, and the escapement wheels, of which there were two, were vertical, with their common arbor at right angles to the verge of the balance; *i. e.* with their planes parallel to the verge: these wheels, which were similar, were placed one opposite the other on contrary sides of the verge in such way, that a tooth of one fell in the middle of the space of the other, and *vice versa*; the pallets were  $\frac{1}{4}$ th of an inch thick, and two and a half twelfths in diameter, and the distance between the ends of the teeth of the double escapement wheel about  $\frac{1}{7}$ th of an inch, or twice as much as the thickness of the pallets; the pallets had their planes parallel to the plane of the balance, and had their semi-circle sloped in an angle of about  $45^\circ$  at the ends for the pallets to slide over, after pressing on their planes alternately during the respective oscillations. We will endeavour to explain the action, as we comprehend it to have been by a verbal description. Let the leading pallet be called *a*, and the following pallet *b*; and let the balance be supposed in motion with a tooth of the escapement wheel resting on the plane of the diamond; when the sloped end of pallet *a* arrives at the said tooth, the tooth falls off, accelerating the balance by its sliding motion, and goes on till an opposite tooth of the other wheel falls on the plane of the diamond in motion; this tooth rests without recoil, as did the former one, till the sloped end of the pallet *b* comes to it, when it falls off in its turn, and gives motion to the balance, which has thus its spring wound up by the momentum of the balance sufficiently far to bring the balance back again after every impulse; and thus an alternation of vibrations is continually maintained while the force of the mainspring lasts. This escapement is also of the second class, or of the dead-beat kind, but is subject to the constant friction of its immediate predecessors, though this friction is greatly diminished by the substitution of the diamond for metallic pallets, and by the bushing of the pivot holes with rubies; it possessed all the good properties of Tompion's escapement just described. (See *Machines and Inventions approuvées, &c.* vol. vii. p. 137.) Larcum Kendal used two crown wheels in a similar manner, which W. Howell improved by adding a forked detent to make the escapement detached, which was rewarded by the Adelpi Society, in 1792. See their *Transactions*, vol. x. p. 216.

6. *Sully's modification of De Baufre's escapement.*—The praise which sir Isaac Newton bestowed on De Baufre's new watch induced H. Sully to bestow much attention on it, and in the year 1721 he adopted an alteration in it, which made only one wheel necessary for the escape at both oscil-

lations;

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lations; but Berthoud has expressed an opinion that his alteration constituted no real improvement, but made the adjustment of the pallets more difficult. Sully having applied his modification of the escapement in question both to a pendulum clock and a marine time-piece, presented two memoirs on its construction to the Royal Academy of Sciences in the years 1723 and 1724; which are also printed in his description of marine time-pieces, published in 1726. *Fig. 1. of Plate XXXII. of Horology*, represents a side view of this escapement, where A is the escapement wheel, B the contrate wheel between it and the balance C, which has a pinion only on its verge, that is actuated by the contrate wheel; the pallets 1, 2, are two circular pieces of agate, placed at the distance from one another of one space of the escapement wheel nearly; these pallets have each an inclined or sloped end, like De Baufre's, the slopes also being at the contrary ends of each; the intention of this modification is not only to make one wheel A perform the whole business of the escapes, but to produce long vibrations of the balance, even beyond a complete circle. The action was thus; on giving motion to the balance C, suppose the tooth *b* to rest on the plane of the pallet or agate 1, it soon meets with the end slope, and falls off till it meets with the pallet 2 below, on which it rests, after having given a push to the pallet during the act of sliding off; the balance goes on, till the spring, now wound up, brings it back, there being in the mean time no recoil, by reason of the arbor of the contrate wheel being also the axis of the pallets, and at right angles thereto; the tooth *b* now finds, after the return of the balance, the sloped end of pallet 2, and escapes entirely; but at the same instant tooth *c*, which follows, falls on the plane of pallet 1, and is then in the same situation we at first found *b* in, therefore the same action is repeated with this, and every succeeding tooth, till the power of the main-spring is exhausted. This modification of De Baufre's escapement is consequently of the second class also, and enables us to comprehend more clearly the action of the original one, which had its double escapement-wheel placed with respect to the balance verge, as the present one has its single one, with respect to the arbor of the contrate wheel. The effect produced must have been nearly the same on the pallets, though the vibrations of the original balance must necessarily have been shorter than of the latter, but then it had not the friction in the wheel-work between the pallets and balances.

7. *Escapement with two cylindrical pallets.*—In the year 1727 Julien le Roy shewed Sully some watches just brought from England into France, which had each two cylindrical pallets with notches cut in them like Tompion's single pallet, which kind of escapement seems to have differed from his, only in having an escape at every vibration, and in having the old crown-wheel as an escapement wheel; but as we have not been able to trace the inventor of this escapement, we must consider it as a lineal descendant from Tompion's, and therefore as a variety of English extraction. Its utility has been, however, evinced by the circumstance of Julien le Roy's having adopted it as a favourite, and used it in some of his productions: it had the property of converting the recoil of the crown-wheel into a dead-beat.

8. *Cylinder or horizontal escapement of Graham.*—We are not informed in what particular year Mr. Geo. Graham, the celebrated watch and clock-maker, invented the escapement with a cylinder, called also the horizontal escapement, from its wheel being in an horizontal position, but it appears that Julien le Roy introduced this construction into France in the year 1728, when wonderful properties were attributed to it, but particularly the property of compensating all the inequalities of the maintaining power, which at that time

was the great desideratum among watch-makers. The contrivance bears a great analogy to Tompion's escapement, and was probably originally derived from his, which, however, does not lessen the merit of the contrivance, as it requires as much ingenuity to improve an existing instrument, frequently, as to invent a new one. *Fig. 2. of Plate XXXII.* is a perspective view of Graham's horizontal escapement, in which A is the escapement-wheel, B the balance, and C the hollow cylinder fixed on the verge of the balance; each tooth of the wheel, which may have any convenient number of teeth, is formed of a triangular inclined plane or wedge, supported by a stem projecting perpendicularly from the plane of the wheel at its circumference; the length of the wedge of each tooth is just a diameter of the internal part of the cylinder, so that the cylinder may revolve round the wedge when the balance is in motion; in this situation the anterior point of the wedge just touches the cylinder's interior surface, but the posterior point of the same is free, so as not to touch and stick fast in the cylinder, but to give it a push on the edge when the contact ceases; the distance between the teeth is also great enough to allow the exterior portion of the cylinder to come between them, when the escape has taken place, and while the balance continues its oscillation. The action is performed in the following manner; suppose the wedge to be just escaping from the hollow part of the cylinder, and to be giving its impulse to the edge of the cylinder which it quits, the balance goes on and winds up the spring, as usual, at the same time presents its exterior face, or convex surface to the point of the succeeding tooth or wedge; this point falls on the said convex surface and rests there, without recoil, till the oscillation is finished, at the return of the balance, by means of the spring now wound up, the hollow or concave part of the cylinder comes to the point of this following wedge, and being rounded at this end, admits it easily into its concavity, at which instant the other edge of the cylinder receives a second impulse in a contrary direction; the balance now makes another oscillation; and the point of the wedge rests against the interior face of the cylinder, as it did before on the exterior, without recoil, and in both situations of rest the wedge has no other effect on the balance than that of retarding it by its pressure against the circular surface; the second tooth is now in the same situation as we found the first, and presently in its turn gives another push at leaving the cylinder altogether, and leaves the third wedge to perform the same office by first resting on the back of the cylinder, then entering it, and lastly giving its parting impulse to the second edge of the said cylinder, as the two wedges that preceded had successively done before. At one period this escapement was in high estimation in England, as well as on the continent, and even now the common watches that are constructed with this escapement will fetch greater prices than those with the ordinary crown-wheel escapement, but the detached escapements of the best chronometers are now held in much higher estimation than either. We have seen that the hollow cylinder, though constituting but one pallet, in effect performs the office of two pallets, and permits but one tooth or wedge to escape entirely at two oscillations, during one of which the point rests at the outside, and during the other at the inside of the cylinder, while the two edges of the cylinder perform the part of separate pallets on receiving separate impulses in contrary directions, it is, therefore, of importance in this, as indeed in all escapements with a regulating spring, that the quiescent position be duly adjusted to render both oscillations precisely similar in extent and duration at each side, otherwise the performance will be a species of hobbling, and the compound law of motion,

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derived from the spring's action and impulses on the pallets conjointly, will be far from regular; consequently not likely to be an isochronal law. Berthoud has described a cylindrical escapement with two balances connected by two pinions, but it did not prove successful.

9. *French escapement a Virgule.*—The French escapement known by the appellation of a *virgule*, from the pallet's resemblance of a *comma*, is represented by *fig. 6* of *Plate XXXV.* A, B, C, are three teeth of the balance wheel, placed very obliquely compared to a true radial line, and carry each a pin at their extreme ends, standing vertically like the supports of Graham's wedges for his cylindrical escapement; the pallet B A has its centre of motion at *e*, the centre of both the concave and convex portion, exactly over the verge of the balance; this centre is in the circumference of the circle that passes through the points or pins of the teeth; the pallet, which is of hardened and polished steel, has its plane parallel to that of the wheel, and is supported between *f* and *e* by a crank piece put over the verge, which cannot be admitted as high as the pallet; this end *ao*, which connects the convex and concave portions, is a portion of an equi-angular spiral, and the part *bd* of the pallet is called the *horn*, probably from its resemblance of the beak of a bird; the inferior face *b A* may be straight like the dotted line, or curved, at the option of the maker, and the superior part *f A* may be of any shape: the convex part *a e f* contains about  $100^\circ$ . The length of the pallet from *a* to *d* is such, that when the pin at B presses against the curved part at *a*, the point *d* of the horn will just miss the pin at A of the preceding tooth, and the height at which the pallet stands is such as to make it pass over the rim of the wheel, but not over the pins at the ends of the teeth. When the balance is at rest, and has its spring in equilibrio, the point *d* of the horn is at the point *i*, about  $30^\circ$  from *d*; but the present position is that which the pallet has when the tooth A has just escaped from the point *d* of the horn. To explain the action, on a supposition that the tooth A has just escaped, the succeeding pin B has just fallen on the point *a*, joining the spiral and convex portions of the pallet, and the balance has just received its impulse from tooth A as it passed from *b* to *d* along the inferior face of the horn; it, therefore, proceeds in its motion in the direction *d g b* of the dotted circle, while the point B slides on the convex side *e f*, and is detained without recoil; when the point *d* of the horn has arrived as far as *h*, more than  $90^\circ$  from A, the momentum of the balance is exhausted, and the balance returns; the point *d* comes to about the point *i* before the pin of tooth B comes to *o*, and enters the concave part of the pallet, where it slides till the point arrives about *k*, where the momentum of the balance spring is again exhausted; the balance returns again, and when the point *d* comes to *i*, the pin of tooth B escapes the concave part at *b*, and slides along the inferior face of the horn, at the same time giving it a push till it escapes entirely, and is in the situation of tooth A, where the process began; in the same manner the following tooth C, and every succeeding tooth in its turn, will fall on the convex side of the pallet, return and enter the concave side, and then finally escape. We must observe, however, that the pallet opposes the motion of the balance as it passes along the small spiral part from *a* to *o*, which may be so proportioned as to be a counterbalance to the impulse previously given to the balance by the leading tooth, in case the friction on the back of the cylindrical part is not competent to retard the balance's impulse sufficiently. The effect produced by this escapement must be very similar to that produced by Graham's cylindrical escapement, but has this advantage, that the inclined plane formed on every wedge of Graham's construction is

transferred to the pallet; and serves for all the pins to slide on in succession, thereby removing the difficulty of forming all the wedges alike in size and shape. Besides, the convex and concave sides of the pallet may be reduced to any dimensions, provided the acting tooth may not slide at once from the spiral to the horn, and allow the train to run down, which may be the case if the parts of action be small, and there be much play in the pivot holes of the wheel and balance. The construction is a compound of Tompion's and Graham's watch escapements, to both of which it has certain points of resemblance. In 1752, Le Paute altered this escapement, by putting pins for teeth in both planes of the wheel, as he did in Amant's escapement a *cheville*, which addition gave it some advantages.

10. *Escapement with one pallet and one detent by Thiout.*—Thiout, a French clock-maker of considerable eminence, published a work in 1741, entitled "Traité de l'Horlogerie Mécanique et Pratique, approuvé par l'Académie Royale des Sciences," 2 vols. 4to, in which he has described an escapement of a watch that has been mistaken sometimes for a real detached escapement, and considered as the first that has been made of such a construction, though the inventor himself did not consider it as such, as is evident from his own description. This escapement is given in *fig. 8.* of *Plate XXXII.*, and to use the author's own account, "it is an escapement of a watch in which half of the vibrations *sem* independent of the train of wheels, while they are performed. The detent B stops the escapement wheel, the balance bringing back the pallet A, the detent recedes, to leave the wheel free to strike the pallet; and so on. This escapement could not perform without a spiral spring."—It hence appears, that the pallet A is on the verge of the balance, but that the detent B is on a separate arbor, while they are connected by the tail of the pallet entering the slit in the remote end of the detent, so that the balance is never disengaged from the detent, and therefore cannot be considered as of the detached class. When the balance moves in a direction from A to B the pallet gets out of the teeth, but the detent falls in, and *vice versa*. The curves of the claw of the detent appear to have been drawn from the centre of its motion, and therefore we are disposed to think that there would be no recoil in the escapement wheel.

11. *The anchor escapement by Clément, or Dr. Hooke.*—While these improvements were going on in watch escapements, an equal attention was paid to the contrivance of new clock-escapements. Huygens had placed the pallets of the crown-wheel escapement at an angle of about  $60^\circ$  instead of  $90^\circ$ , as they were made for a watch, in order that they might be accommodated to the short vibrations of a pendulum, or rather, perhaps, to the vibrations of some length performed in a cycloidal curve, by means of his cycloidal cheeks near the point of suspension; but still the arc of action on the pallets was too long to allow practice and theory to coincide, as to the performance of long and short arcs of vibration in the same time. The preference that seemed due to short arcs, when circular, suggested the propriety of contriving an escapement that would admit of very short arcs of vibration. This was first effected about the year 1680 according to Smith's account, by Clément, who was a clock-maker in London; but Dr. Hooke has disputed the priority of the invention, and has affirmed that he exhibited a pendulum with what is now known by the name of the *anchor* escapement, to the Royal Society of London, in the year 1666, soon after the great fire of that year. We will not endeavour to settle the point that relates to priority of invention, but proceed to describe the contrivance itself, which has continued, and is likely to continue, to be of permanent

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nse in ordinary clocks. *Fig. 3.* of our last named plate is the representation of the anchor escapement, as it is commonly constructed for a pendulum clock that swings seconds, which pendulum, in conjunction with the anchor escapement, gained the appellation of the *Royal pendulum*. The escapement, or swing-wheel *A*, has usually thirty teeth, when a vibration is performed exactly in a second, in which case a second's hand is usually inserted on its elongated pivot, to indicate seconds; but if no attention is intended to be shewn to the indication of seconds, the train may be made to admit of any other convenient number of teeth; *B C* is the anchor and pallets, taking its name from a resemblance to a ship's anchor, that may be observed in its shape; the distance from its centre of motion *a* to that of the wheel *b* is determined by the number of teeth that the pallets take in between them, it being essential to the freedom of action that two lines, drawn from the two centres of motion *a* and *b*, should constitute a right angle at each of the two points of action, as seen included by the dotted lines, meeting at the ends of the acting teeth *d* and *e*: in the pallets which we have made to include nine teeth, the centre of the pallet's motion falls at the point *a*, but if they were made to include eleven teeth the said point would fall above at *h*; and if they included fewer than nine the point for the centre of motion would fall below *a*: in general ten or twelve are contained between the pallets of a second's pendulum, but this must depend on the arc that the pendulum is intended to vibrate; for the more teeth are taken in, the greater is the distance of the two centres of motion, and consequently the smaller the angle or arc of action on the pallets. If a circle *fg* be described by a radius equal to half the distance of the centres of motion *a b*, round the point *a*, the two faces of the pallets *B* and *C* usually lie in the tangent lines *ei* and *dg* of that circle, which lines are the guides for making the slopes. The action of the escapement before us may be explained thus; suppose the tooth *d*, seen resting on the slope of pallet *C*, to be urging this pallet outwards from the centre of the wheel, by which a motive force is applied to the moving pendulum through the medium of the crutch; presently it escapes, and pallet *B* is brought inwards towards *b*, so as just to avoid the tooth *e*; the wheel is now at liberty to move, and goes on, by the force of the maintaining power, till the succeeding tooth *k* falls on the sloped face of pallet *B*, which is now urged outwards, and endeavours to give a contrary motion to the pendulum; but the momentum of the moving pendulum is too powerful for its impulse, and carries the tooth *k* back again till the momentum is expended, at which instant a recoil of the wheel and second's hand placed on its arbor take place; presently the pendulum returns, and the tooth *k* now pushes it on, and escapes; the pallet *C* is now brought back, so that the tooth following *d* falls on its sloped face, and in its turn experiences a recoil till the pendulum returns, when it pushes on and escapes; then another tooth next after *k* falls on the face of *B*, and experiences the same recoil and subsequent power of escaping that the others did; and thus the alternate vibrations of the pendulum are perpetuated as long as the maintaining power continues. The effect of this escapement on the pendulum is similar to that of the crown-wheel escapement on the balance; the pendulum is either accelerated or retarded in every part of its vibration, except during the almost insensible instant of the drop of the succeeding tooth, when one has escaped; but as the momentum of a heavy pendulum in motion is greatly exceeding that of a balance in motion, the bad effect is smaller in degree. When an additional weight is added to the weight constituting the maintaining power, the arc of vibration is increased, whence one might be led to ex-

pect a retardation in the time of a vibration, the arcs being circular; but the fact is, that the vibration is accelerated very sensibly by means of the pendulum being both accelerated in its descent and opposed in its ascent, and the pendulum comes sooner back than gravity alone would bring it. Here then the compound law of motion differs from the simple law of gravity, but not in the ratio of the arcs to the sines of the angle of vibration; for if the compound law were to the simple law of gravity as the arcs are to their sines, the vibrations would be isochronal, whatever their extent might be. It is hardly necessary to add that this escapement is one of the first class.

12. *Graham's dead-beat.*—The dead-beat escapement, as originally contrived by Graham, is a modification of the anchor escapement we have just described, from which it differs only by taking off a part of the slope of each pallet, and by making the pads, that is, the back of one pallet and interior part of the other, portions of circles described from the anchor's centre of motion, so that when the point of a tooth rests on those parts, while the pendulum is finishing a vibration, no recoil takes place, but the wheel continues motionless, or, as it were, *dead*. *Fig. 4.* of the same plate gives the figure of the dead-beat escapement-wheel and pallets, where we have represented the wheel, as we did the wheel of recoil, with only four instead of six radii, that there might be more space for our geometrical lines. In this construction, as in the preceding one, the distance of the centres of motion *a, b*, is determined by the tangent lines meeting the radii at the points of the acting teeth; when this distance is an exact diameter of the escapement wheel, we find that the pallets take in just ten teeth out of thirty, which is the case in the figure before us, but when twelve teeth are taken in, the centre of the anchor's motion falls at *h*, just a diameter and a half from the centre of the wheel; and this is Berthoud's rule for giving the distance *a b* without any reference to the tangent and radius; for he has found that the arcs of action on the slopes of the pallets *a m n*, and *a o p*, are each only one degree, but that if fewer teeth than twelve were included between the pallets, the anchor would be shorter, and the arcs of action proportionally longer. This rule might be a good one with a given maintaining power, that is, where the whole arc of vibration is of a given extent, but it does not follow that one degree for the arc of action before the escape is the best in all cases where the motive powers vary. We are of opinion that experiments might be instituted to ascertain this important point, by applying various weights successively, first with pallets that have twelve teeth included, and then with such as have eleven, ten, &c. but the experiment could not go beyond 14 teeth, because when half the wheel is included the tangent becomes a vertical line, parallel to the line of distance *a b*, and therefore this distance becomes *infinite*. There is probably a certain maintaining power that is best for a certain angle of action, with a pendulum of a given weight, but that does not seem to have been ascertained either by calculation or experiment hitherto. The thing to be aimed at is, to make the compound law of the pendulum's motion such that the varying forces may accelerate or retard it in proportion to the arcs of distance from the lowest point, which is the case with the simple law of gravity, as it regards the sines of the said arcs. We have put the same letters of reference to our present figure as to *fig. 3.*, that the reader may the more easily comprehend the correspondence between them, and to prevent the necessity of further minute description of the parts; the slope of the pallets being determined by the same-tangent lines *ei* and *d g*, as before. We shall, therefore, confine the remainder

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of our description to the features that differ, and to the mode of action depending thereon. The circle B C, passing the points of the first and eleventh teeth, including the ten spaces between the pallets, forms the interior faces of the said pallets B and C, and the exterior portions B e and C d are formed by a concentric circle of larger radius. These circles are described from the point a, or centre of the anchor's motion, therefore a tooth resting at any time against any one of those circular portions remains without recoil; the distance between the said circles is somewhat less than one-half of the space contained between the extreme ends of any two contiguous teeth, and the nearer it is to one-half of a space, the smaller will be the drop after an escape, or, as the workmen say, the closer the pallets will be laid. The teeth are somewhat varied in shape from the inclined teeth of the recoil escapement, a portion of the slope at the bottom being cut away, that the end of the pallet may enter the space, when the pendulum vibrates beyond the arc of action, without coming in contact with the metal of the wheel, which would make the pendulum rebound, and disturb the regularity of the vibration. These observations being premised, the reader will now be prepared to comprehend the action. The tooth at e has just passed the slope of pallet B, and is escaping, after having given its stroke or impulse gradually, in sliding along the slope from e to its present situation; the pallet B is now going from the centre of the wheel's motion b, and the pallet C is come back from its excursion, in time to allow the tooth b to fall on its inner circular part, near the angular point of the slope; the pendulum goes on in its vibration till its gravity overcomes its momentum, during which time, the pallet B is no longer in contact with the wheel, but the pallet C enters the space between b and d, and the point of the tooth b rests on the inner circle of the pallet; presently the pendulum returns, the point of tooth b slides back again till the slope b d presents itself, when urged by the maintaining power, it escapes after having made its push to the pallet C, which now continues its motion outwards, and consequently pallet B falls in the way of the tooth k, which follows, but which rests on the exterior circle B e of this pallet, till the pendulum returns as before; it then meets the slope at e, and, giving its push to the pallet, escapes, as its preceding tooth had done; and thus the vibrations are alternately aided in future, while, as has been seen, one tooth only completely escapes at the interval of two vibrations: which is the reason why a wheel of 30 teeth is proper for the indication of 60 vibrations of a second's pendulum. When the wheel is made of hardened steel, and the pallets of ruby or agate, the friction is greatly diminished, and will admit a short angle of action, or diminution of power.

13. *Modification of the dead beat by Grignon.*—When we gave the "History of the successive Improvements in Clocks," under our article CLOCK, we said that the senior Thomas Grignon, of Covent Garden, London, improved the dead-beat escapement of Graham, and presented a clock to the Society of Arts in 1759, which remains in one of their rooms to this day, that has got this improved escapement, the peculiar property of which is said to be, that it performed alike with *four* and with *twelve* pounds suspended as a maintaining power; if this is a fact, the escapement must have the property, so much desired in all escapements, of rendering all the arcs of vibration isochronal. We have been favoured with a manuscript account of this escapement, and of its principle of construction. It will be doing but justice to the memory of departed genius, if we give the author's own figures, demonstration, and account of his improvement, as he has left it in his own hand-writing. *Fig.*

5. of Plate XXXII. is the *scheme*, and *fig. 6.* the *demonstration*, as the author himself has intitled the figures, the latter of which has no letters of reference, but is sufficiently intelligible in conjunction with the other. "It appears from the scheme," says the author, "that the distance of the centre of the pallets from the centre of the swing wheel in that machine (at the Adelphi) is *one whole diameter* of the wheel, which has this peculiar excellence, that the triangles formed at the ends of the pallets, by drawing the tangents for the slopements are *equal*; (nor indeed can they ever be equal, continues he, where the distance is more or less than *one whole diameter* of the swing wheel,) and, on the contrary, where that distance is duly observed, all the triangles will ever be equal; for then all the interfections, made by drawing the two tangents to the circle of the pallets, will fall exactly alike, (*fig. 6.*) intersecting the intermediate circle, as may be seen by the figure, consequently the tangent lines, together with the chord of the swing wheel form a rectangled triangle, the upper angle of which, by altering the slopement only, changes its place in the circumference of the circle, the same chord always continuing its base. For a farther demonstration of which, see 21<sup>st</sup> proposition of the the 3<sup>d</sup> book of Euclid.

"Again, when the distance is duly observed, we shall find that one of the lines for the slopement of the pallets will be the hypotenuse, and the other the perpendicular of rectangled triangles, whose bases are equal to  $120^\circ$ , the halves of which must be  $60^\circ$ . That they are rectangled triangles may be easily proved; for if the base be  $120^\circ$ , and perpendicular  $60^\circ$ , the hypotenuse must be  $180^\circ$ . See 1<sup>st</sup> Prop. of the 12<sup>th</sup> book of Euclid."

In another manuscript paper, Mr. Grignon says, "that the teeth of the swing wheel have an equal effort, when they act upon the slopements or faces of the two levers or pallets, may be thus demonstrated.

"Draw the lines A, A, upon the faces or slopements of the pallets or levers a, a, now these are the lines of direction; let fall the perpendiculars B, B, from the centre of motion of the pallets C; now, I say, that if you measure the lengths of these perpendiculars, they give you the efforts of the arms of the levers or pallets D C, D C; for by the 9<sup>th</sup> prop. of Mr. De la Hire's Treatise of Mechanics, the efforts of a weight or power are not to be measured by the length of the arms of the levers, but by perpendiculars drawn from the hypomochlion upon the lines of direction of the weight or power. That these levers are equal is thus proved; for, taking C for your centre, describe the circle E E E; now if the perpendiculars B, B, are both radii of the circle E E E, they must, of consequence, be equal, which is what was to be proved. Again, that the faces or slopements of the pallets or levers are equal may also be thus proved: a A, a A, are the lines of direction of the action of the teeth, and being both tangents of the same circle E E E are consequently equal."

The remarks that have occurred to us on contemplating Mr. Grignon's *scheme*, as he has called it, are, first, that his distance between the centres of motion require *ten teeth* out of thirty to be taken in by his pallets, as we have shewn in our last article; secondly, the circle E E E is described with less than half the distance of the centres, and is yet made the circle to which the tangents are drawn, that form the slopes, the reason of which he has explained, the radius C B of this circle, it appears, must be determined by a line a A, drawn parallel to the line of distance, which must be a tangent to the said circle, and which affords an easy and practicable mode of drawing the slopes agreeably to this construction; thirdly, if the slopes thus formed by tangents

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drawn to a diminished circle have the isochronal property, they are worthy of future imitation, under the circumstance particularly of ten teeth being included between the pallets; and lastly, we observe, that the *same circle* forms the exterior curve of one pallet, and the interior one of the other, which is not the case with Graham's pallets, but which certainly makes the friction alike on both pallets, seeing the circular surfaces rubbed by the points of the wheel's teeth are at equal distances from their common centre of motion. These considerations are all in favour of Mr. Grignon's modification of the dead-beat escapement, as each excursion of the pendulum must be influenced by similar circumstances, and if moreover it possesses the isochronal property attributed to it, it is somewhat remarkable, that the Adelphi society have been labouring to reward inferior escapements in great variety, while one of the best *dead-beat* escapements is beating *dead* to the society, having *escaped* their notice, while performing its functions within their own walls.

14. *Mr. Bennett's modification of the dead-beat.*—Mr. J. Bennett of Norwich has published an account of what he considers an improved method of describing the curves and faces of Graham's dead-beat pallets (see Nicholson's Jour. vol. xv. 8vo.) which account we think deserves a place here in common with Grignon's method.

Draw the line A B (*fig. 7. Plate XXXII.*) says the author, on which describe the circle B, the size of the intended swing wheel; then, according to the number of teeth the pallets are intended to escape over say, as 60 (the double of the number of the wheel's teeth) is to 360°, so is double the number intended and one more to that proportion; thus, suppose the number intended to escape over nine, the double of which is 18, to which add one, and there are 19; then say,

As 60 : 360° :: 19 : 114°; the half of 114°, which is the whole arc included, is 57°; then on the circle already drawn set off on each side of the line A B 57°, from which points draw lines to the centre of the circle; then on these points where the circle is crossed erect perpendiculars, which will intersect at the centre of the pallet's motion in the line A: from this point as a centre draw the arc C C, to cut the points where the radial lines cut the circle; the arc thus drawn describes the receiving and leaving pads of the pallets. The inclination or inclined plane of each pallet must form an angle of 60° with the said radial lines; thus from the points of intersection, near E and G, draw the small semi-circles D and G with any radius, and set off 60° from *f* to *g* on the semi-circle D, and from *b* to *m* on the semi-circle G, then will lines drawn from the centres of the semi-circles, through the points *g* and *m* respectively, give the proper direction of the slopes of the pallets' faces.

This construction is very similar to Grignon's, though differently projected: the centre of motion A is determined in the usual way, and the odd unit given to double the number of teeth included is an allowance for the breadth of the pallet, to have as little drop as possible; the slope of the pallet G is parallel to the line A B, in Grignon's construction, but is not quite so here, for the difference of the angles at the opposite sides of the radial line is  $60^\circ - 57^\circ = 3^\circ$ , which is what these lines want of being parallel, which quantity of deviation seems to constitute the principal difference between the two constructions; if the radial line of pallet G had been drawn to the lower point of the pallet, so as to have made the angle at the centre 60°, and the teeth included had been exactly ten, then the two methods would have coincided, and the point A of the pallets' motion would have been an exact diameter of the wheel from its centre.

We conceive that the effects of the two constructions may be so nearly alike, that their difference in practice may be almost imperceptible. If there is any difference, varying the maintaining power considerably in different trials will detect it, by rendering the alterations in the rates perceptible from the comparisons. Otherwise the alternate angles might each have been 57°, instead of one of them being 60°.

15. *Isochronal escapement for a pendulum.*—So long ago as about the year 1720 Saurin, Julien le Roy, and Enderlin, wrote memoirs on the nature of the curve that was necessary to give to the pallets of an anchor, instead of the concentric circles, in order that the swing wheel may have just so much recoil only, as will render all vibrations, performed in arcs of different extent, isochronal; and since their time Berthoud in France, Reid in Edinburgh, Melville and others in London, have put in practice a method of constructing pallets founded upon the same principle. We think it not improbable, however, but that the Scotch and English artificers have borrowed their contrivance from the French author, who published his construction in his "Essai sur l'Horlogerie" in the year 1786, before which time we do not find any traces of an isochronal escapement except Grignon's just described, and Smeaton's, which follows. The construction of the escapement in question differs from the dead-beat only in one particular, which is, that the circular portions of the pallets, which in the dead beat are concentric, described from the centre of the pallet's motion, in the isochronal escapement are *excentric*, with respect to each other, those curves on which the ends of the teeth of the swing wheel rest being described from points out of the centre of motion. Berthoud had made several experiments with different escapements, and different maintaining powers, from which he found that the same addition to the power which accelerated the vibrations of the pendulum, when a recoil escapement was used, retarded the same when a dead-beat escapement was substituted; hence he concluded that there must be a medium between much recoil and no recoil, which would make the pendulum vibrate in the same time in all arcs, or, which is the same thing, with any addition or diminution of the maintaining power; he therefore fixed, after various trials, on a construction producing but a *small recoil*, which answered his most sanguine expectations, and which we shall be happy to describe here, particularly as it promises to answer a better purpose than the common dead-beat, which has been long in high estimation; and as it has not, we believe, been described by any English author. *Fig. 1. of Plate XXXIII.* is a plan of Berthoud's isochronal escapement, where A, as before, is the swing-wheel, B and C the pallets of the anchor, and *a* the centre of their motion; the distance of the centres *a, b* also, as before, depending on the number of teeth taken in by the pallets; the angles *man* and *oap*, are the angles of action by which Berthoud has given his slopes of the pallets without the tangent lines *ei*, and *dg*, but we have thought it right to shew how they may be given both ways. Berthoud's method of sloping to suit any angle previously given is more extensive in its application, but the quantity and direction of the impulse will vary as the angles *man*, and *oap* vary; whereas the method of sloping by the tangent lines can only vary by varying the circle *fg*, as Grignon has proposed: in our plan we have taken the circle's diameter equal to the distance *ab* of the centres for the sake of uniformity of plan, that the reader may see how the pallets, so formed, differ in shape from the dead-beat pallets. The exterior portion of the circle *dC*, of pallet C, is described with the extent *ad* from the centre *a*, but the interior portion *b4* is described with the same extent from a point *4* below

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below the centre; the difficulty consists in determining the true situation of this excentric point 5; Berthoud's rule, founded on the result of experiments, is this; having determined the breadth of the pallets, equal to somewhat less than half a space of the swing-wheel, describe from *b*, in the line *a p*, the concentric dotted circle 1, 2, 3, &c. set the distance between the two concentric circles, or breadth of the pallet, *three times* over along the inner curve to 1, 2, and 3, then in a direction from 3 towards *a* set the same *once* to 4; in the next place, with the extent *a b* find the point 5 by intersection from the points *b* and 4, and this point 5 is the excentric point desired, from which the curve *b 4* is described with the extent *a b* as before, which is the interior curve to be substituted for the concentric curve 1, 2, 3 of the dead-beat escapement; and it is evident that while the pendulum is in motion inwards, with a tooth resting on this excentric curve, the wheel must have a certain recoil. Again, the exterior curve of excentricity, of pallet B, is thus described; the curve 1, 2, 3, &c. is described, from the point of the tooth that is in the line *a m*, and the points therein are taken as before at the distance from each other of the breadth of the pallet, or at somewhat less than half a space of the wheel; the point 4 is here set outwards in the direction from *a* to 3; then with the extent *a e* the excentric point 6 is determined by intersection from *e* and 4, which point is above the centre; lastly, with the extent *a e*, as before, describe the excentric curve *e 4* from the point 6, which being substituted for the concentric circle 1, 2, and 3, will produce a similar recoil in the pallet B, as the curve *b 4* produces in pallet C. The inner curve of pallet B having no action, like the outer curve of pallet C, may be described from *a*, or be a straight line. The writer of this article has a half-second's pendulum clock with this escapement, and Troughton's tubular pendulum, which goes admirably with any power that will keep it in motion.

16. *Smeaton's escapement of the turret-clock at Greenwich.*—The escapement which Mr. Smeaton contrived for the turret clock at Greenwich resembles the isochronal escapement, which we have just described, in a certain degree, and was, no doubt, intended to answer the same purpose. *Fig. 2. of Plate XXXIII.* contains the plan of this escapement, in which *A B* is the radius of the escapement wheel; *BC* a tangent line at  $3\frac{3}{4}$  teeth from the vertex, drawn from *C*, the centre of the pallet's motion; *B D E* is a circle described from the centre *C* through the points *B* and *E*, which are each  $3\frac{3}{4}$  teeth from the vertex; *FG* is a line drawn parallel to the vertical line *A C* at the distance from the vertex of  $3\frac{1}{2}$  teeth, and cutting the circle *B D E* in the point *G*; then *G C B* is half of the angle of vibration, and setting off the arc *B H = B G*, *G C H* will be the whole angle of vibration. Draw the line *CH* cutting *FG* in *I*, and through the point *G* of this pallet from the centre *A* describe a circle that may cut the radius *A K* in the point *K*; this will be the point of the other pallet; the line *EC* being also a tangent to the wheel at  $3\frac{3}{4}$  teeth from the vertex. Now setting off *K L* on the circular arc = *GH*, the angle of vibration *K C L* will be equal to the other angle of vibration *G C H*, and if through the point *L* the line *CL* be produced, and *I M* be set off = *I H*, then will the wheel move equally forward, by a similar motion of each pallet. Again, with the radius *K C*, upon *K* as a centre, describe the arc *C N*, and also with the same radius from the point *M* describe the intersecting arc *O P*; then from *Q*, the point of intersection with the radius unaltered, describe the curve through the two points *K* and *M* to *R*, which curve will give the working face of the pallet that will produce a small recoil nearly equal to that produced by the plane *G I*; in this construction

the depth of the teeth is equal to a space contained between two contiguous teeth, and the acting side of the tooth is a portion of a circle described from the bottom of the sloped side of the *fifth tooth* inclusive. The circle to which the slope of the tooth is a tangent is  $\frac{1}{6}$ th of the diameter of the wheel. When the swing-wheel has a greater number of teeth than 30,  $7\frac{1}{4}$  teeth are still contained between the pallets, and the centre of their motion is determined, as in the former constructions, by a tangent line drawn from the point of the acting tooth. The two ends of the anchor may be made more apparently equal in length by letting the pallet *K* escape over  $3\frac{1}{4}$  teeth and the pallet *G* over  $4\frac{1}{4}$ , in which case the arc *B D* will be of a greater radius than the arc *N D*. The steel pallets or end-pieces are fixed by screws that allow an adjustment for distance or depth of the pallets, so that they may be detached, newly formed, and replaced, at any time after they have been in use.

17. *Escapement with two levers by De Bethune.*—Thiout says that De Bethune was the first contriver of the clock escapement with two detached levers, and that the origin of this construction was derived from the escapement of Dr. Hooke, or of a German artist, with two balances, which we have described. Thiout made the first of his in the year 1727, and says that from that time the escapement with two levers became common among clock makers in France. *Fig. 3.* of our last plate is a representation of this escapement as made for a pendulum; where *A* and *B* are the two levers placed fast on each a separate arbor included within the frame; to the lever *B* is attached the crutch or fork that communicates with the pendulum not seen, and the fork *C* which is visible in the figure; the lever *A* has a bar of metal *D* fast to it, that carries the roller *E*, of a diameter equal to the aperture of the fork *C*; and the ends of these levers constitute the pallets placed at the distance from each other of five out of thirty teeth of the swing wheel. During the action of this escapement, when one of the levers is acted on by a tooth, the roller and fork are raised up, and the other lever becomes a detent to the wheel; then when at the next vibration the other lever is acted upon, the roller and fork are depressed, and the first lever in its turn becomes a detent; and thus the vibrations are alternately assisted while the maintaining power continues to actuate the swing wheel. This escapement has a recoil, and Julien le Roy discovered (*Memoire sur l'Horlogerie par M. le Roy, fils aîné de Julien le Roy, 1750*) that when the levers are each the exact length of the radius of the swing wheel, it possesses the isochronal property, that is, all arcs of vibration will be performed with it in the same time. We are not aware that this escapement was ever made in England.

18. *Dead-beat escapement for a pendulum by Anant, (a cheville)*—*Fig. 4.* of the same plate shews the plan of an escapement by Anant, formerly a clock-maker at Paris, that has an escapement wheel without teeth, but with pins or pegs inserted in a concentric circle in the plane of the wheel, as appears in the figure; the pallets *A* and *B* are both fast to the verge or arbor of the crutch, in the usual way, and are brought so nearly together that the same pin that slides along the sloped face of one pallet *B* immediately falls on the inner circle of the other pallet *A*, and continues without recoil till the pendulum has made its vibration; at the return of the pendulum the pin meets with the sloped face of pallet *A* and escapes; then the next pin falls on the interior circle of pallet *B*, and remains without recoil till the pendulum returns from its vibration, when it slides down the slope and gives a push to the pallet as the first one did before; thus the two pallets are alternately actuated by the same pin before

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its final escape, and sixty vibrations are made during one revolution of the plate with thirty pins. The slopes appear to stand at right angles to each other, but it is not said, in the account we have seen, how either of the slopes ought to be drawn geometrically. This is the kind of escapement at present used in the large turret clock at Hampton Court, and we have seen many other clocks in England with a similar escapement, which, we have no doubt, may perform as well as with the ordinary dead-beat escapement as originally constructed by Graham, provided the drop from the first to the second pallet, which must necessarily be equal to the thickness of the pin, do not produce a jerk that may affect the vibrating pendulum.

19. *Dead-beat escapement (a cheville) by J. A. le Paute.*—In Le Paute's "Traité d'Horlogerie," published at Paris in 1755, is an account of a dead-beat escapement as made by him for a clock, which differs from our last by Amant only in its mode of position, and which therefore requires no figure for its description; the levers of the two pallets open like a pair of dividers to any extent, but are not in the same plane, one of the levers being over the anterior plane of the pin wheel, and the other over the posterior plane; hence two sets of pins are necessary, one on each plane; but the action is the same as we have described it in Amant's escapement, which it probably excels inasmuch as the drop may here be made as little as possible, because the same pin is not required to pass between the ends of the pallets in escaping; but one pin acts only with one pallet before it escapes; there are consequently sixty pins in all, thirty on each plane of the wheel.

The same author also published an account of a watch escapement with pins (a cheville) which the reader will find described at page 198 of the same treatise.

It is easy to conceive, after what we have said about the isochronal pallets, that both Amant's and Le Paute's escapements, and indeed all the dead-beat escapements, may be made to have a little recoil, so as to become of the isochronal kind, provided the acting concentric circles of the pallets were made in a certain degree eccentric; that is, if they were described from points out of the centre of motion of the pallets themselves. The only difficulty is in determining the situation of those points under different circumstances, which we think is a fair object for future experiments.

20. *Harrison's clock escapement.*—The escapements which we have hitherto described require oil on the pallets, to diminish the friction of the parts that rub against one another in action; but the escapement we are now going to describe as the invention of the ingenious Harrison requires no oil, on account of his construction being free from rubbing at the time of the pallets' action. *Fig. 5. of Plate XXXIII.* exhibits the shape of Harrison's escapement. G D O is a portion of the flying wheel, moving round M as a centre: A is the verge or arbor of the crutch that communicates with the rod of the pendulum; to this are attached the pallets, each consisting of a long and a short lever with a joint at the place of union; the short lever A B is fast to the arbor or axis of motion, and carries the longer lever B C which has a claw or hook a C, and a slender spring is so applied as to keep these two levers nearly at right angles to each other; at right angles to A B is also the other short lever A E fast likewise to the axis of motion, and bearing the longer lever E F, as A B bears the lever B C; the joints are at B and E, and a similar small spring holds the levers A E and E F in like manner at right angles to each other, when not otherwise acted on. The lever E F has not only a claw, like the other long lever, but a heel to it; or projecting part f. The action of this contrivance may be thus

explained; suppose the tooth D urging the pallet or claw C, while the pendulum is moving towards the right hand in its excursion; this pressure of the tooth produces a tendency in the lever B C to move round, but the joint at B yields, and opens the angle A B C a little; during this motion round A, the short lever A E is lowered a little, and with it the long lever E F, which we will call the detent; its claw F therefore falls in the way of the tooth G, which now drops on the back part of the claw, and is inserted into a notch under the projecting heel f; the further motion of the pendulum, and consequent depression of the short lever A E, carry the end of the tooth G back again till the vibration is finished, and produce a recoil. At the moment when the tooth begins to have a recoil, the tooth D at the pallet or claw C is withdrawn and escapes; the slender spring of the lever B C, which had been bent from its quiescent state, now resumes its original situation, and throws out the lever B C, till its angle formed at B is again nearly a right angle; in the mean time the wheel is detained by the heel of the detent E F, in which situation it opposes the vibration through the medium of the two levers E F and E A, which are attached to the crutch of the pendulum. The vibration being finished, the pendulum returns towards the left, and the wheel is at liberty to advance again; the pressure of the tooth G on the claw of the detent now assists the vibration through the arc of escapement or arc of action, and causes the pallet C to approach the wheel, till the tooth following D falls on it and experiences a recoil in its turn. This recoil sets the detent F at liberty from the pressure of the tooth G, which now flies back by means of its slender spring to its rectangular situation, as it regards the small lever A E: presently this vibration terminates and the pendulum returns, while the tooth following D aids its vibration by pulling forwards the pallet C, when the process of making two successive vibrations is gone through, and the same operation is repeated. The reader will have observed in this account that the tooth and pallet, or tooth and detent, do not slide on one another, but give each other a *direct push*, or pull, the business of the small springs being to remove them from contact by one sudden leap, where rubbing is altogether avoided, which contrivance supercedes the necessity of having oil applied to the pallets, and is certainly an ingenious contrivance, as well as useful in practice. It must be observed, however, that the recoil, such as it is, takes place at the extremities of the vibration, when the momentum of the pendulum is almost exhausted, and is therefore the most unfavourable part of the vibration to occur in; notwithstanding which disadvantage the escapement has performed as well as any other that had preceded, perhaps as well as any that has followed it, as the regulator to which it was applied has seldom if ever been excelled in steadiness and accuracy of performance for fourteen years of uninterrupted succession. The imperfection arising from the recoil taking place at the extremities of the vibrations seems to have been compensated by the immense momentum of the pendulum that this escapement admitted of with a comparatively small maintaining power, while the absence of friction and of oil gave it the advantage of permanently uniform action. Of course the pendulum was of the grid-iron form, that compensated the effects of varying temperature, and allowed the escapement to have its merit appreciated. The report of the performance of Harrison's regulator with the escapement in question was, that it did not vary *one second* per day from any preceding or following day for the space of fourteen years, and that the aggregate of the variations from true mean time did not amount to half a minute.

Haley also constructed clock pallets that required no oil,

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but as none of them have fallen under our notice, we pretend not to say how they differed from Harrison's.

21. *Escapement by Alex. Cumming for a clock.*—Mr. Cumming published his elements of clock and watch-making in the year 1766, in which, among other matters, he describes a construction of an escapement of his contrivance, that removes the friction and influence of oil not only during the time of rest of the pallets, but also during the motion of the swing wheel, so far as they can influence the vibrations of the pendulum; and also obviates all the irregularities that can possibly arise from the maintaining power as transmitted through the train. *Fig. 6. of Plate XXXIII.* exhibits as much of this escapement as is necessary for explaining its general action, but those readers who wish to see all the minutiae of the construction, as represented by different plates of sections, must have recourse to the book itself, as the complexity of the parts represented in various points of view demands more minute representation than our plan admits of. Our figure is a copy of plate 5 of the author, in which A B C is the escapement or swing-wheel; D E the pallets separately moveable on the axis of motion, and having each a little ball or weight H and I respectively supported by horizontal arms; each pallet with its attached weight is separately moveable from the other round its respective axis of motion, so that when one is raised by the wheel the other remains at rest; F and G are two detents firmly attached together, like the ordinary pallets of a common dead-beat or recoil escapement, and are fixed to a cylinder of brass P P, that surrounds the two axes of motion of the pallets, which are in the same straight line but separated from each other at the middle of the cylinder, where is a partition that bears the interior pivot of one axis and the exterior one of the other; the crutch of the pendulum is also fast to the cylinder; so that the two detents and crutch move together along with the cylinder, without the motion of either pallet; and each pallet can move separately without the detents and crutch. M is a load to counterpoise the detents and crutch in any position given them; and *n o* are two pins carried by the pendulum that project far enough to fall alternately in the way of the arms that carry the balls H, I, as the pendulum vibrates.

To explain the action of this escapement, let us suppose the pallets D and E, the detents G and F, the crutch L, and pins *n* and *o*, together with the balls H and I to be exactly as represented in the figure, where the lever of the detent G is hid behind the lever of the pallet E, but may be conceived to be parallel to it, the pallet D having been previously lifted from its quiescent position, where its point rested on the rim near the foot of tooth A; then if we conceive the pendulum moving from right to left with the ball I urging the pin *o* attached to an arc fixed to the pendulum, or crutch of the pendulum, the vibration is aided by the gravity alone of this ball. The arc, that bears the pins *n* and *o*, has a contrivance not seen in the figure for unlocking the detents at the moment when either of the pins bears against its ball, which contrivance it will be sufficient for our purpose to call Z. Conceive now the pin *n* brought into contact with the arm of ball D by the moving pendulum, the detent F is unlocked, and the tooth A of the wheel quits the end of pallet D; the ball H now acts by its gravity on pin *n*, and descends, at the same time aiding the returning vibration, while the pallet D, united to the arm of ball H, descends also towards the wheel; but as soon as the pendulum first began its original vibration, the pin *o* was withdrawn from the pressure of the ball I, by means of the attached pallet E falling on the tooth C of the wheel, so that all the latter part of the vibration was free; this

pressure of pallet E on the tooth C diminished the pressure of tooth A on the detent F at the instant of the unlocking, which we have mentioned; the wheel now in motion by the action of the maintaining power, (through the medium of the train,) goes on till the tooth C, acting on the pallet E, raises it outwards, together with its attached ball I, till the detent G stops the wheel's motion, when all the parts are at rest till the pendulum nearly finishes its returning vibration, and then its pin *o*, meeting with the elevated arm of ball I, presses against it and concludes the vibration; at the moment this pressure is felt the contrivance Z unlocks the detent G, and allows the tooth C to escape; in the mean time the ball I by its gravity urges the pendulum for a short time, while the tooth following A, meeting with pallet D, raises it and the ball H a second time, the tooth following C comes in the way of pallet E, and stops the further action of the ball I on the pendulum, which now vibrates, as before, free, till its pin *n* again meets with the arm of ball H, when the same process is repeated; and thus the weights H and I are alternately raised by the wheel, and then alternately act for a short time on the pendulum, at the beginning of each vibration, so that gravity alone is properly speaking the maintaining power of the pendulum, and whatever may be the maintaining power of the train, it never affects the motion of the pendulum; but only raises the balls, that afterwards act on the pendulum by their gravity alternately exerted from a state of rest. Thus, whatever may be the effects of oil, dust, friction, wear, &c. on the action of the train of wheel-work, as it has no immediate connection with the pendulum, except during the small instant of unlocking the detents, these effects are almost entirely avoided, as they regard the pendulum or regulating part of the motions. The greatest objection in theory to this construction is, that the additional gravity commences instantaneously, and also ceases instantaneously, and at a part of the vibration where the instantaneous exertion of extraneous force of any sort is the least favourable for aiding the simple gravity of the pendulum's ball, which consideration is analogous to the observation we had occasion to make on Harrison's escapement; but, like his, the escapement before us has stood the test of practical experience, notwithstanding its complexity, in his majesty's private observatory. If, however, this escapement is not better than any of the other escapements, the number of its adjustments, and variety of its parts, constitute a practical objection to its general adoption; and we believe no proof has been given of its being preferable to Harrison's, or even to the common dead-beat or isochronal escapements, except that the works of the clock that has this escapement may not require to be so often cleaned. This escapement leaving the pendulum free or detached from the wheel-work during the greatest part of each vibration, is of the third class of escapements.

22. *Escapement by Mudge for a clock.*—The clock escapement contrived by Mr. Mudge to detach the pendulum from the train, so as to allow it to have nearly a free vibration maintained by gravity alone, may be considered as a simplification of Cumming's escapement just described, from which its principal difference is, that each of his two separate pallets act also as detents; the mode of action and effect produced are very similar in both. Mr. Mudge's escapement is represented by *fig. 7.* of our last plate, in which L M is a portion of the swing wheel; G A and G B are two levers separately moveable round one common axis of motion, and have each a pallet at the lower extremities; these pallets are formed like the common recoil pallets, except that each has a claw at the lowest point, that prevents the escape of the sliding tooth when acting thereon: the pallet G A has a lever, which

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which may be called its tail-piece *G O*, attached to it, and also a small metallic ball *u* surmounted on a pin over the pallet, which may be easily changed for one of a different weight; the pallet *G B* has a similar tail-piece *I O*, with a similar ball *v* over its pallet *B*; and the dark circular spot at *N* is the end of a stiff pin projecting from the pendulum, or its crutch, far enough to fall in the way of the tail-pieces alternately, as the pendulum vibrates. After having perused our account of the action of the preceding escapement, the reader will anticipate the explanation we have to offer of this mechanism. Suppose the wheel to be urged by the train in its proper direction from *I* towards *M*, and an impulse given to the pendulum, to produce a motion in it in a contrary direction; the pin *N* keeps pace with the pendulum towards *L*, while the tooth at *L* is locked in the claw of pallet *A*, (which it is supposed to have raised so as to bring the tail-piece *G O* out of its vertical direction,) and at length meets with this tail-piece, to which it gives a push, at the extremity of the vibration, sufficiently strong to drive the pallet *A* from its locked tooth *L*, when the wheel is at liberty to proceed, till the tooth near pallet *B* raises it and its surmounted ball *v* until the claw detains the further motion; in the mean time the returning vibration commences, and the ball *u* urges the pendulum, by means of its tail-piece *G O* being in contact with the pin *N*; when, however, the tail-piece has gained its vertical situation, the pallet *A* meeting with the rim of the wheel stops; the pendulum now finishes its vibration in a detached state, having gained an accession of force by the impulse from the ball *u* downwards, which has been greater than the resistance it met with in moving upwards at the instant of unlocking: the tail-piece *J O* is now in the situation of *I P*, by reason of the ball *v* being elevated by the wheel, therefore when the pin *N* of the pendulum arrives at *I P*, which is at the other extremity nearly of the returning vibration, its stroke drives the pallet *B* in its turn from the locked tooth near *M*, which now escapes; the wheel is again at liberty to proceed till the tooth behind *L* has raised the pallet *A* a second time, when it is again locked; the pendulum begins another vibration, aided by the ball *v*, till its tail-piece resumes its vertical position, and then the pendulum is again detached, after being a second time urged down a longer arc than it was moved up; and thus the vibrations are maintained by the excess of the downward push over the resistance upwards at every new vibration, which excess, derived from gravity alone, is in fact the maintaining power of the pendulum. This escapement is also of the third class, and being more simple in its construction than its predecessor and parent, perhaps we may add, is better adapted for practice. The external force derived from the gravity of the balls in aid of the pendulum's gravity is here also both applied and withdrawn suddenly, as well as at the most unfavourable parts of the vibration, as was the case with Cumming's escapement; but it possesses the same advantages of detachment from the train.

23. *Detached escapement by Peter le Roy in 1748.*—We have deviated a little from the regular order of time, in having noticed the detached clock-escapements before those that were previously applied to the balance, in order that the succession of improvements made in clock-escapements might not be interrupted by an intermixture with watch-escapements. We now go back again to the year 1748, when Peter, the eldest son of Julien le Roy, invented an escapement for a balance that vibrated a considerable portion of its total arc without any connection whatever with the escapement wheel, and which therefore may be considered as the father of the third class of escapements, and the origin of the subsequent more recent improvements in the escape-

ment of chronometers. *Fig. 8 of Plate XXXIII.* will afford us the means of explaining this escapement, a model of which was presented to the Academy of Sciences at Paris in the year 1748, previously to which year, no detached escapement had been made public, though Du Tertre is said to have invented one, and even to have made it at the time; but as the invention, or at least the construction, was kept a secret, it did not derogate from the merit of Peter le Roy's contrivance, which must be considered as original. *G H* is the escapement wheel of the contrary kind, actuated by a pinion on its arbor, receiving the force of the maintaining power; its profile is seen contiguous to it, at *g b*; *T V* is the balance, the verge of which has a spiral spring attached to it at the interior end in the usual way; a curved pallet *A E* is fast to the verge under the balance, and the semi-circular piece *C I* is affixed to the same above the balance, but under the spiral spring; the end *C* of this piece is rounded, and so situated, that a line drawn from it to the centre of the balance would form with the curve *A E* an angle of about  $80^{\circ}$ . An angular lever *Q P X*, turning on pivots under a little cock on the plate at *C*, is so proportioned, that the branch *P Q* will reach the pallet, while the other branch *P X* with a concave end will reach to a tooth *G* in the balance wheel, when not resting on a pin *K*, to which in its quiescent state it is kept by the spring *R M*, made fast to the plate on the other side at *R*. Suppose now, the regulating spring moved from its state of natural rest, and the balance to move with it through a certain arc of vibration, more or less, till the rounded end *C* of the semi-circular piece falls on the branch *P Q* of the angular lever near *Q*, and pushes it from its situation, at the same time bringing the concave end of branch *P X* into the way of a tooth *G* of the wheel; when the acting tooth, which we will call *D*, escapes the pallet *A E*; the wheel is then at liberty till its tooth *G* falls on the concave end of the branch *P X*, which may be called the detent, because it now *detains* the wheel from moving further under existing circumstances. The balance is now perfectly free from all contact of the acting part of the branch *P Q*, and continues its vibration, after having received a push from tooth *D* on its pallet: presently its velocity is destroyed by the tension of the regulating spring, the re-action of which now makes it return with an accelerated motion, when the pallet comes into contact with the escapement wheel at the tooth following *D*, which now experiences a recoil for about half of a space in the wheel: the branch *P X*, or detent, is relieved by this partial recoil, and obeys its spring *R M*, which takes it back again to its state of rest at the pin *K*; when the wheel, having stopped the balance, sends it off again with a new impulse, by striking the pallet in a contrary direction, when the same operation of the angular lever is repeated, and the vibrations are maintained as in other escapements. It must be remarked of this escapement, that it does not allow the balance to be detached for an entire vibration, but opposes the balance back from the point where it gave its forward push, thereby producing a certain recoil, which, so far as this is a leading consideration, would entitle us to rank the escapement among those of the first class, but inasmuch as the balance vibrates in a detached or free state in the remaining portion of its vibration, we may place this escapement with propriety at the head, in point of time of the third class.

24. *Peter le Roy's second or improved detached escapement.*—Some time after Peter le Roy had completed his first detached escapement, and had considered its principal defects, he set about contriving another, less liable to objections, in which he succeeded in a very considerable degree: when in

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the year 1766 he presented a time-piece to the Academy of Sciences, which was afterwards tried at sea by the French government, with his improved escapement, which we shall now describe. *Figs. 1, 2, and 3, of Plate XXXIV.* exhibit sufficient of Peter le Roy's improved escapement to enable our readers to form a complete idea of its construction; the leading feature of which is to give the balance one temporary push that shall maintain its motion for two successive vibrations, one forwards and the other back, and that this push may be given at a moment of the balance's vibration that is most favourable for avoiding a derangement of the law of the spring's forces. *Fig. 1.* is a view of the balance-wheel, which has six radial levers for teeth, but no rim, that it may be as light as possible, the ends of which levers are bent downwards, that is, in an opposite direction to those on the horizontal wheel with Graham's cylinder escapement; the connection of this horizontal balance-wheel with the train is by means of the pinion on the opposite end of its arbor; *fig. 2.* is the arbor of the detents, on which there are three levers, one double one for locking, and two single ones for unlocking, all clearly shewn in the figure; *fig. 3.* shews the wheel, detents, unlocking levers, and balance in their relative situations, and in one of the acting positions: *A* is a portion of the balance, on the plane of which is screwed a pallet *p*, so as to fall in the way of one of the levers of the balance-wheel. The same letters denote the same parts in *fig. 3.* as in *figs. 1 and 2,* which therefore explain themselves. The action may be explained thus: suppose one of the levers of the balance-wheel to be detained by the claw of the detent *D*, while the balance put in motion is vibrating in the direction from *i* to *A*; when the force of the balance spring, not seen, overcomes the momentum of the balance, it returns by means of the spring's force, which is now at its greatest tension, or distance from the point of quiescence; the direction of the balance, we have said, is now from *A* towards *i*; in this return a pin at *i*, situated in the superior plane of the balance, strikes the end of the lever *H F* of the detent arbor, unlocks by this stroke the detent *D* from the claw of the wheel's radial bar or tooth, and at the same instant directs the other end *H e* of the double detent into the way of a succeeding radial bar of the wheel *K r*, which now rests on this end of the detent; this part of the action is called by the inventor the *preparation*, the vibration goes on to finish, and the spring brings the balance back; at a certain part of this vibration the balance receives its stroke from the radial bar *K*, which impels the pallet *p*, screwed on the balance itself, in this manner; a pin, situated like the former pin at *i*, but placed on the inferior plane of the balance, out of sight, and a little farther from the balance's centre than the former pin, strikes the end of the short lever *H e*, and unlocks the radial bar of the wheel, that has been resting against the opposite end of the detent *D*, and that now runs on to *D*, which is in the way to catch it; during this short period the wheel is free, the pallet *p* of the balance being at that instant in the situation *F*, the point *K* of the radial bar *K r* of the wheel pursues the pallet and makes its stroke on it, about the time when the balance spring, as we suppose, is at its quiescent point, and therefore when the balance is moving with its most accelerated velocity; the stroke is of short duration on that account, as well as on account of the short distance the wheel has to run before it is again detained by the detent *D*: the backward vibration is made as before, and the same process is repeated of two lockings and unlockings at each stroke of the wheel on the balance. The stroke, however, which the balance receives, has more force than both the strokes that its pins give in the acts of unlocking, and

therefore the difference of these contrary strokes constitutes the real maintaining power of the balance, which was of the thermometrical kind, with alcohol and quicksilver, as described under our article *COMPENSATION-BALANCE*. The step made towards perfection, when this escapement was devised, was very long, and the principal objection to it in practice is, that it has too many pivots that require oil, as well other parts that come successively in contact during the action, which therefore are not sufficiently free from friction and consequent wear. It may be necessary to add, that to prevent the detent's being displaced by any jerk, a long tail-piece behind it is contiguous to a circular appendage of the balance, seen from *i* to *F*, against which it falls; but only when any derangement of the detent accidentally takes place, and thus reinstates it. The stroke is given to the balance not only when its velocity is greatest and least liable to be deranged, but the pallet that receives it, being removed from the centre of the balance, requires but a comparatively small impulse in this situation; besides, the spring, which the inventor considered as not desirable, for holding the angular lever to its place of locking, is here entirely dispensed with. This was considered as an improvement at the time, but subsequent experience has proved the utility of spring detents, which are now in universal use in the best English chronometers.

25. *Detached escapement by F. Berthoud.*—Ferdinand Berthoud, one of the members of the National Institute of France, and the author of various works on horology, has contrived different escapements for clocks and watches at different times, and has written more on the subject than any other author, but it will not come within our plan to detail here all the alterations that have presented themselves to him; we shall satisfy ourselves with describing a few of those which he has himself selected as most worthy of public notice in his last publication; "Histoire de la Mesure du Temps." Others may be seen in his "Traité des Horloges Marines;" or in the "Supplément" to that work. The first that we mean to describe is contained in *fig. 4.* of *Plate XXXIV.*, which is a perspective view of all the parts necessary to be seen: *A* represents the verge of the balance, to which is affixed by two screws the circle of escapement *B* as a pallet; *C* is the escapement wheel, *a b c* the detent, which has at *b* a claw to catch a tooth of the wheel, when it suspends its motion, during the period of the balance's free vibration; the portion *a b* of the detent is a flexible spring, that yields first at the point *a*; this, therefore, is the *spring of the detent*; the other part *b c* properly forms the detent, which has a claw rounded at the end *c*; another slender spring *b e* lies cross-wise near the said end, and is held fast to the circle *B* by a screw and fixing-piece *f*; this second spring carries a pin *d* near its extreme end, which acting on the end of the detent, disengages the locked tooth of the wheel, when the balance vibrates in a direction from *B* towards *A*; at that instant the succeeding tooth of the wheel acts on the notch or pallet part of the circular piece *B* at *b*, and transmits an accession of force to the balance, which now vibrates in free space; at the balance's return, the pin *d* of the small spring *d e*, borne by the balance's circular piece *B*, applies itself to the end of the detent, so as to slide past it without disturbing its position with regard to the claw, against which the next tooth is now resting; when the balance has finished this second vibration it returns, the pin *d* again pushes aside the detent, and unlocks the wheel, which now gives another push at *b*, and the same operation is resumed that we have been describing. Thus two vibrations are performed at once unlocking, and at one stroke of the wheel on the notch of the circular pallet piece. The small spring *b e* may be

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be called the lifting spring, in opposition to the detent spring, or spring detent; and to give a clear idea how it detaches the claw of the detent in passing forwards, but not in passing back again, it may be necessary to observe, that this lifting-spring has a pin in the circular piece B, against which it rests, to prevent its laying too much hold on the back sloping part of the detent's extremity; but it is at liberty to yield in the contrary direction towards the verge of the balance; and as the spring is very slender, and has its yielding point or centre of motion at the remote end *e*, it gives way to the detent in the direction that pushes the detent against the tooth of the wheel, which becomes a prop to steady it; but when the impulse is in a contrary direction, the detent, having no such prop, and its end being at that side suited to receive the blow of the pin without its sliding, itself yields and withdraws its claw from the wheel, which is then unlocked. The spring of the detent is also confined from rebounding too far by a pin *g* fixed in the plate. Here we have an instance of a retrograde step in the improvement of escapements, the spring which Peter le Roy laboured to reject in his second construction is here resumed with an additional spring, and the adoption of the *spring-detent* has become general in the subsequent constructions. Berthoud began his detached escapements in the year 1754.

26. *Another modification of a detached escapement by Berthoud.*—The escapement which Berthoud employed in some of his watches, particularly N° 60, was considered by him to be more sure in its action than the preceding one, as well as more easy of construction; *fig. 5.* of the same plate represents the plan of one of these escapements, where L is the escapement wheel; *m* the circle of escapement carried on the verge of the balance; *p or r* the detent, the claw of which at *r* suspends the motion of the wheel; the verge carries above the circle *m* a small tube made fast by friction, and to this tube is made fast a projecting forked claw, in which a pin is adjusted to act on the detent and raise it. The pin, which we will call *s*, in turning in one direction, acts on the part *p* of the detent, and withdraws the claw *r* from the wheel; this is now at liberty to impel the circle *m* by its notch and with it the balance; the slender spring *u* brings back the claw of the detent, and the vibration goes on; at its return the pin meets with the end of the detent-spring fixed on an arm at *t*, this spring yields to the retrograde motion of the balance. The balance at its return makes its pin (of the fork) urge the spring *p* against a pin *s* in the arm *n* of the detent; this arm turning on its centre of motion, withdraws the claw of the detent from the wheel, which now acts again on the notch of the circle *m*, as before. The pin *q* serves as a stop to the detent, and the arm *k* of precaution is to lock the wheel when the balance is dismounted.

27. *Another escapement without a spring by Berthoud.*—*Fig. 6.* of the last plate is a view of an escapement by Berthoud, in which he has dispensed with springs altogether. The action of the wheel A is transmitted to the balance, as before, by the notch of the circular piece B on the verge; the present position of the parts is for the moment when the detent allows the wheel to begin its action on the notch of B. The detent C has two arms, with each a claw *a* and *b*, the faces of which are circular; the claw *a* serves to suspend the action of the wheel after its stroke is made; but the claw *b* receives the tooth of the wheel when the balance in its return makes the tooth at *a* to escape. These effects are produced by two levers C *d*, C *e*, forming the fork that moves the detent C: this fork is fixed on the centre C of the detent, and its levers lie one above the other. The lever C *d*, which is contiguous to the detent, corresponds to

the small semi-circular piece *d e*, placed on the circle of escapement B; this semi-circle is notched by lines, one of which tends to the centre; this side of the notch unlocks the wheel by its action on the arm C *d* whenever the balance retrogrades from the first vibration of the pair; during this effect the wheel advances but a short way, just sufficient to unlock the claw *a*, and to suffer the balance to proceed in its retrogradation. The balance, having finished in a detached state this second vibration, returns, when the semi-circle *f g*, placed over the other semi-circle, and notched in like manner, presents its acting side to the upper arm *f C* of the fork, and unlocks the tooth at claw *b*; at this moment another tooth, catching the notch at *e* of the circular piece B, gives it another impulse, and consequently puts the balance in a state of renewed force, and the process already described is renewed, while the semi-circular pieces *d e* and *f g* on the verge alternately serve to keep the arms C *d* and C *e* of the fork in a firm position to ensure the desired effects of the escapement. It is easy to perceive that there must be much friction in this escapement, and that the semi-circular pieces on the verge of the balance, if not somehow counterpoised, must affect the rate of going in different positions of the time-piece.

28. *Detached escapement with a detent and spring by Berthoud.*—*Fig. 7.* of the same plate is the plan of another of Berthoud's escapements with a detent and spring, and that which we understand has been most copied by others. It was used in the author's marine time-piece N° 9. A is the circle of escapement; C the wheel; *a b d* the detent with three arms; the arm *a* suspends the motion of the wheel while the balance oscillates in a free state; the spring *d* serves to bring the detent *a* back again as soon as the pallet *c* has ceased to act on the arm *b*; at that moment one of the teeth of the wheel impels the circle by acting on the roller *h*, and communicates its force to the balance; this having finished its oscillation returns, and in the return the pallet *c* meets with the end *b* of the detent, which turns the pallet back towards B, the centre of the circle, till it has passed without unlocking the wheel; its spring *b* brings the pallet back again to its original state of rest on the pin at *e*, the oscillation ceases, and in the return of the balance the pallet *c* again meets with the arm *b* of the detent, which it turns aside, the tooth being no prop to it in this direction; the unlocking therefore takes place; the wheel's motion is resumed, and a new impulse is given to the moving balance. Here the detents are arms or levers acted on by a separate spring, as is also the pallet, consequently there still remain pivots that require oil, though we are disposed to consider this as the best of Berthoud's watch escapements; perhaps equal to any of the English constructions.

29. *Isochronal escapement of a watch by F. Berthoud.*—Among the other contrivances of Berthoud is an escapement for a watch with isochronal pallets, similar to those applied to a pendulum which we have described above, but the mode of applying them is different. In *fig. 8.* of our last plate, A is the escapement wheel; B the anchor with the isochronal pallets producing a small recoil, and formed in the manner before described, (*see fig. 1.* of Plate XXXIII.) C D the balance; *a* a pinion on the verge above the wheel, that is actuated by a sectoral toothed piece *b*, attached to the anchor of the pallets, and moving with it round the common centre of motion of it and the pallets at E; the intention of this construction is to produce a long oscillation of the balance compared to the motion of the wheel and toothed sectoral piece, and to render all the oscillations, however long or short, of equal duration, the arcs of action being large in proportion to the whole oscillations. This construction may

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may have given rise to that which is now known by the name of the Liverpool escapement, which so greatly resembles it, that they may be considered as the same thing. We obtained a watch by Litherland of Liverpool, with a view of giving a separate description and drawing, but we found that the only difference is, that the pallets are placed a little on one side of the wheel, instead of the three pivots being in one straight line, and that the centre of the pallet's motion is between the verge and pallets requiring a counterpoise behind: a further description is therefore unnecessary.

30. *Modern escapements of English chronometers.*—If we had not already anticipated our descriptions of the modern escapements for chronometers, as they are now made in England, we should have given them a place here; but as we have been very minute in our account of the escapements of Messrs. Mudge, Arnold, the Brockbanks, and Earnshaw, under our article CHRONOMETER, and have given drawings of them in our *Plates XIII. XIV. and XV.*, it would be superfluous to enter into a second detail of the same here, and therefore we pass over them by a simple reference to the article already named.

It may not be improper to mention here, that Mr. John Watkin, of West Smithfield, has proposed an alteration in the situation of the pallets in the modern spring-detent escapement, for which he received thirty guineas as a premium from the Adelphi Society, in the year 1804. His alteration consists in bringing the pallets into a situation between the centre and circumference of the wheel, and making the wheel a contrate one with the teeth upwards. (See the *Transactions of the Society*, vol. xxiii. p. 375.)

31. *Mudge's forked escapement.*—Mr. Mudge contrived another detached escapement besides the one we have referred to as already described, which we shall now notice, though he did not seem to place so much value on it as Emery, Margetts, and others have done after him; we shall not be able to make the reader comprehend the construction without two figures: *fig. 1.* of *Plate XXXV.* is the plan of this escapement, and *fig. 2.* a profile or side view of the frame that contains the mechanism: A is the escapement wheel, B the anchor of the pallets, which are of Graham's dead-beat kind adapted to a watch, and which give the necessary force to the balance for maintaining its motion; *a* is the centre of motion of the anchor, nearer to the wheel than to the balance; *b* is the forked part of the anchor, the two prongs of which appear in *fig. 1.* to be close together in the same plane, but *fig. 2.* shews that they are one above the other. The pallets are on the verge of the balance, and are of the cylindrical sort, one above the other, so as to fall in the way of the two prongs alternately, pallet 1 is urged by *b*, and pallet 2 by the other prong in its turn; the time of action of the prongs on the two pallets is very short, and the blows are made alternately one in each vibration; the remainder of the vibration is perfectly free, the wheel being in the intervals resting on the circular portions or pads of the anchor's pallets, which may in this case be considered as detents and pallets alternately. A time-piece by Emery with this escapement performed with wonderful accuracy, though the detachment continues only for a portion of one vibration before the balance has its force renewed, which consequently might be supposed to have its motion more disturbed than if the impulse had been given at each alternate vibration. The queen's watch by Mudge with this escapement had a slight recoil, which kept one of the prongs pressing gently against the cylinder of the verge to steady the fork. The performance was excellent.

32. *Margetts' modification of Mudge's forked escapement.*—The late ingenious Margetts adopted Mr. Mudge's escape-

ment, which we have just described, for his chronometers that indicated both solar and sidereal time, but made some alterations with the fork. *Fig. 3.* of the same plate shews the plan and profile of Margetts' modification, where A is the wheel; *a b* the anchor moveable at *a*; *b* the fork where the prongs are in the same plane; *c* a piece of steel carrying a pin *e* under its extreme end that strikes the prongs of the fork *b* alternately, one at each oscillation of the balance *g*, which strokes unlock the wheel; *b* and *i* are two banking screws, the points of which act as stops to the anchor at opposite sides of the centre of motion, and keep the fork in its place to be caught by the pin *e*, one or other of them at each vibration; *d* is a circular piece of metal, under the pallet piece *c*, that has a notch in it bounded by straight lines going towards its centre; and *f* is a pin carried under the anchor, as seen in the figure, the end of which gives the circular piece *d* a push, by acting on its notched side at each unlocking of the wheel, thereby aiding the vibration: the pin *f* is always at the notch when the pin *e* is in the fork, therefore the notch in *d* and the pin in *e* are always placed in the same vertical line over one another, and as they move together on the verge will always remain so, while the pin *f* and fork *b* are also together on the anchor. The writer of the present article has a chronometer by Margetts with this escapement, which acts very well when stationary, but when carried in the pocket the pin is apt to catch the outside of the prong, when any jerk has sent the anchor back during the balance's excursion.

33. *Modification of Mudge's forked escapement by R. Robin of Paris.*—R. Robin, a watch-maker of Paris, published a memoir in 1794, containing an account of a free escapement, which he considered as new, but which we consider as another modification of Mr. Mudge's forked escapement, though we allow that in theory it appears to be an improvement. *Fig. 4.* of the same plate is a plan of this escapement, in which the wheel restores the exhausted force of the balance once only in two vibrations, which circumstance constitutes the improvement; to effect this, pallets G *a*, and G *b*, acting as detents; are made of unequal length from G, the centre of their motion, and the fork, which is seen separately at *e*, as well as the tooth or pallet *d* and lever *f*, are concealed under B, the circular piece carried by the balance; the fork *e* is fast to the end of one of the pallets *a*, instead of forming an anchor with the pallets, but this shape makes no difference in the action; the lever *f* is also fast to the same underneath the fork; but the tooth *d*, which acts with the fork, is fast to the verge under B, as we have already said. We have given three positions of the circular part B and pallets, to shew more clearly the nature of the action, as some of the acting parts are concealed. One of the claws *a* of the pallets being removed, the wheel A escapes, and acts on the notch of the piece B, thereby aiding the balance; the claw *b* receives another tooth and holds it as a detent, and the balance finishes its oscillation; at its return it unlocks the tooth at *b*, which is the longer pallet, and the wheel runs on a very short way till a leading tooth falls on the pallet *a*, and the balance vibrates without a new push; at its return the tooth at *a* is unlocked, and its escaping tooth gives the notch of B another push, which serves for other two vibrations; but if the two ends of the pallets G *b*, and G *a*, had been of equal lengths, the escapement would have acted in the usual way, and would have given its push at each oscillation. The manner in which this effect is produced, however, does not yet appear evident; the lever *f*, which is fast to the end *a* of the pallet or detent G *a*, rests in a groove made in a circular collet on the verge, and holds the fork *e* from going on one side, like as the banking

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screws do in Margetts' escapement, then the tooth *d*, fast to the balance, strikes the two prongs of the forks alternately, one at each vibration, which strokes make two unlockings during the time that one push is made to the balance by a tooth; because the said tooth previously made two steps forward, one long and one short, before it escaped to make its push. We have not been informed how this modification performed, but we see no reason to doubt its competency, while we see much reason to admire the ingenuity of the application of two detents of unequal length, formed like the pallets of the anchor escapement, which detents we have named pallets on that account.

34. *Prior's modification of Mudge's forked escapement.*—In the year 1798 Mr. John Prior received 30 guineas as a premium from the Society for the Encouragement of Arts at the Adelphi, for his invention of what he considered a new detached escapement; but its fork differs from Mudge's principally in its having a roller for a pallet borne by an arbor carried by the balance itself; the wheel of escapement, together with its acting pallets, were similar to Le Paute's improvement on Amant's wheel, and therefore had nothing original in it. The reader who wishes to see the account and drawings of this escapement, composed as it is of Mudge's and Le Paute's contrivances, which notwithstanding the author might not have seen or known, may find it in the 16th vol. of the Transactions of the Society just named, and also in the 2d vol. of Nicholson's Journal, 4to. ed. p. 363 and 364, where the editor has remarked that Mr. Crothwaite of Dublin had made a pendulum clock with similar pallets in 1788, which was described in the Memoirs of the Irish Acad. vol. ii.

Prior junior has very recently been rewarded by the same society for another escapement contrived by him for a clock, but the account of it is not yet published in their Transactions, and therefore cannot with propriety be given here.

35. *Duplex escapement.*—We are not informed who was the original contriver of the escapement known by the name of Duplex escapement, a name probably taken from the circumstance of its having a wheel with two sets of teeth necessary for the escaping; neither are we aware of its date; but the esteem in which it is held by those who have tried it, entitle it to a place in our collection. *Fig. 5. of Plate XXXV.* exhibits on a large scale enough of the acting parts to enable us to convey an idea of its action. A B is a part of the escapement wheel, having teeth *a, b, c,* &c. at the periphery, intended for detaining the wheel while it oscillates beyond the angle of action. An agate cylinder *def*, placed on the verge of the balance, acts with these teeth to produce the desired effect. This cylindrical agate has a notch *d*, which passes by the tooth at D, that is supposed to rest on the cylindrical surface, when the motion is in the direction *def*; but when the motion of the cylinder is in the contrary direction *fed*, the tooth at D falls into the notch and accompanies it, pressing on one of its sides till the notch comes into the situation *d*: the tooth, then at the situation of *b*, escapes from the notch, and a succeeding tooth falls on the convex surface of the cylinder at D. The other set of teeth are erect on the plane of the wheel's rim, and are strong and squared at the sides; they stand a little short of the middle of the spaces between the pointed teeth on the edge of the wheel, but consist of the same number; they are to be seen at *b, i,* &c. denoted by darkened parallelograms: above the small cylinder we have named as being made of agate, is a larger one E F G without a notch, and placed high enough on the verge to go over the edge of the wheel's rim; this bears a pallet of ruby or sapphire G, long enough to fall in the way of the square vertical teeth,

when they happen to be near the line joining the centres of motion of the balance and wheel, but short enough to avoid touching the teeth when not near that line. The larger cylinder is so placed with respect to the small one, that when the tooth *b* has just escaped from the notch, the pallet G has just passed the square tooth *b*, which was at A, while D rested on the small cylinder, but is moved from A to *b*, while D moves to *b*. The wheel is now free, and the tooth *b* exerts its force, derived from the main-spring, in the most direct way on the pallet G, and urges it forward till another tooth on the edge falls on the convex part of the small cylinder *def*, and the same action that has been described is resumed. The angle of action in this escapement depends partly on the length of the pallet G, and partly on the diameter of the small agate cylinder, and advance of tooth D into the notch; for when a horizontal tooth on the edge falls on the said small cylinder, the motion of the wheel is arrested, and the vertical square tooth ceases to impel the pallet G so far as it otherwise would have done. This escapement requires very little oil on the small agate cylinder, and none at all on the pallet G, which receives a direct push without friction, and its excellence is considered as at least equal to that of Graham's horizontal or cylindrical escapement.

36. *Free escapement under the pendulum.*—The clock escapements which we have before described suppose a connection with the upper end of the pendulum, which is the most common connection, but there are escapements that give their impulse at the inferior end, one of which is represented by *fig. 8. of Plate XXXV.* which we shall now describe, though we know not who was its original contriver. The part A B D C is made fast to the rod of the pendulum, and vibrates therewith; at B is a joint on which the lever B C is moveable; so that when the end C meets with any resistance the lever mounts upwards at this end, but cannot fall below a horizontal line; it terminates in a claw with both an interior and exterior slope or inclined plane; D is a pallet of agate or other polished stone, with a flat face next the end C of the lever, and made fast into the vertical part A D; F G H I is a two-armed detent, moveable round H as a centre, but kept in its present position against the stop or pin K, by means of the weight G, when not otherwise acted on. In the present position the arm H I, which forms the detent, detains the tooth I of a vertical wheel of escapement, while the pendulum is supposed to be vibrating clear of all the teeth. Let us suppose the end C of the horizontal lever, moving with the pendulum, to be approaching the end F of the second arm of the detent; presently it gives the end F a blow, the lever C flies up, slides over the inclined face of F, and returns into its horizontal position; when the vibration terminates, the pendulum returns by virtue of its gravity, and the interior face of claw C catches the exterior one of the arm F, and gives it a pull sufficient to draw the end of H I from the tooth I; the wheel is then at liberty to run on till the tooth E, moving faster than the pendulum, overtakes the pallet D, and gives it a direct push forwards; this push aids the claw C to get over the claw of F, and the weight G replaces the arm H I to catch the following tooth M, which prevents the further impulse of the wheel on the pallet D, and suffers the pendulum to finish its vibration in free space; at the return of the pendulum the same operation is repeated, and the pendulum continues to receive one push at every two vibrations, and that when the pendulum is in its vertical position, or moving with its greatest velocity, which we have said is the most favourable point of the arc. The arc of action, before the pallet is quitted, depends greatly on the

## E S C A P E M E N T.

the radius of the wheel compared to the length of the pendulum, when the number of teeth is limited. The pendulum, however, ought to be of the compensating kind, otherwise an increase in the length of the rod will derange the action of the claw C, with the claw F, as well as of the tooth on the pallet D, in all the extremes of atmospheric temperature. The maintaining power of the train that actuates the wheel E M may be either a spring or weight, as the mechanist may think proper. Berthoud has proposed this construction of a free escapement for a half-second's pendulum in his "Histoire de la Mesure du Temps," tome i. p. 214; but he does not clearly say that it was of his own contrivance; on examining his drawings, since our observations were written on this escapement, we find that this author proposed a compensation pendulum to be used with it; and he proposes such a combination of parts as a proper model for an astronomical clock to vibrate half-seconds. Mr. Nicholson, who has also described the same escapement as one he has noticed in England, does not venture to ascribe its invention to any particular artist.

37. *Detached escapement of a clock by Berthoud.*—Among the numerous contrivances of F. Berthoud in clock-work, we frequently find this author applying the same contrivance to answer different purposes; for instance, when he had hit upon an isochronal escapement for a clock, he adapted it soon after, as we have seen, to a watch; and in the instance before us, he has converted a free or detached escapement of a watch into a clock escapement, which we shall here describe, not knowing the exact date of the application. *Fig. 1.* of *Plate XXXVI.* is a representation of an escapement of the third class adapted to a half second's pendulum, as described by Berthoud himself. F is the escapement wheel, and *a, b,* the detents of escapement, (formed like the pallets of the dead-beat escapement of Graham,) the action of the wheel F is transmitted to the pendulum by means of the notch made in the circular portion of the escapement piece A B, thus; the detent has two claws, *a* and *b,* formed by portions of a circle, at the holding parts. The claw *a* serves to suspend the action of the wheel, when it has communicated its motion to the notch of the escapement piece, which this does again to the pendulum, by means of the lever C, which it carries, and of the roller D, corresponding to the pendulum. The claw *b* serves to receive, and to detain the wheel, when the pendulum returns. These effects are produced by two levers *d, c, e, c,* fixed on the centre *c* of the detent; but one of them more distant from the plane than the other. These two levers form a fork that corresponds to the circle of escapement *b g.* The lever *d, c,* which is nearest to the detent, answers to one portion of the circle *g,* carried by the circle of the escapement D. This part *g* presents a straight line to the fork *d,* which being acted on, detaches the claw *a* of the detent, and, consequently, sets the wheel at liberty. The notch *f* presents itself, and the tooth of the wheel acts on the notch, and restores to the pendulum the force that it had lost. The wheel having finished its action on the notch *f,* a tooth presents itself to the claw *b,* and the pendulum finishes its vibration in a free manner, at its return, the portion of the circle *g,* which is most elevated, meets with the arm *e* of the fork, and disengages the claw *d;* the tooth that was here detained now escapes, and runs on a short space before another tooth drops on the claw *a,* and the process is repeated. We have not seen this escapement in England.

38. *Escapement by Mr. Nicholson.*—Some time in the year 1734, Mr. Nicholson says (Phil. Jour. vol. ii. 4to. p. 59.) that he contrived a clock escapement to go without oil, and which is of the dead-beat kind; it was constructed in the

year 1798, and when the account was written had been going freely for a year or more. His account is this, *fig. 2.* of *Plate XXXVI.* "is a sketch, in which G H represents a steel wheel; D and E are pallets of agate, with flat polished faces. The pallet D is fixed to the lever D C, which is confined to its present situation by the loaded branch or arm C B resting on the stop *k.* The lever E C is also kept in its situation by the loaded arm C A resting upon *l.* A pin N proceeds from the pendulum rod to its situation between the levers. The centre of motion of the pendulum is in the continuation of the axis of the pallets. Suppose the vibrations to be begun; the pin N in its progress will lift the pallet D towards L, while part of the weight B will be supported by the tooth of the wheel which will follow, and at last escape and suffer the opposite tooth F to fall on the pallet E. But in its return, or descent, the pendulum will be acted on by the whole weight B, and, consequently, its vibration will be kept up. When the pin N raises the pallet E, a similar effect will take place on the side of the perpendicular towards M, and thus the process will go on as long as the wheel G H retains any force." In this escapement, the two weights are not raised entirely by the action of the wheel, but are chiefly lifted by the pendulum itself; therefore though the vibration is made during the repose of the wheel, in a state detached from the train, yet the pendulum is not detached from the weights, and, consequently, the compound law of forces by which the pendulum is maintained consists of the action of the pendulum's gravity, of the action of the ball's gravity, which acts in concert with the other, and of a short action of the wheel on the agate pallet; this compound action differs from Mudge's and Cumming's in this respect, that their weights are raised by the wheel entirely without opposing the pendulum, otherwise than by the short stroke made at unlocking.

39. *Crank escapement by Simon Goodrich.*—In the year 1799 the Adelphi Society rewarded Mr. Goodrich for his contrivance of a crank escapement, which is exhibited in *figs. 3.* and *4.* of *Plate XXXVI.* of which *fig. 3.* is a front view, and *fig. 4.* a side view of the same, where the same letters of reference apply to both. A A A A is the back plate of a clock frame; B the crank fixed to the end of C the arbor of the last pinion of the train; D, D, are two small wire chains, composed of two links only attached to the crank B, by means of two coilets, with great liberty of play. These chains are fastened to E, E, two small springs screwed to F F F, a bar that goes across, and is fastened in the middle to G G, the crutch of the pendulum. I, I, are two screws going through the bar F; the ends of which being made to act against the springs E, E, serve to adjust them to a proper distance and degree of strength, and by that means easily to put the pendulum into proper beat. In *fig. 3.* the pendulum is partly represented by dotted lines, in order to shew the crank, &c. The advantages attributed to this construction are, simplicity of construction and consequent cheapness; total silence during the escape; uniformity of action on the pendulum; durability and certainty of continuance; and the power of acting without oil. These properties may recommend the escapement before us, but as its influence on the pendulum is constant, it is but ill calculated to counteract any irregularities in the maintaining power as transmitted and varied by the train under different circumstances of wear, dirt, and friction. The originality of the contrivance is that of a rotatory motion converted into a vibratory one, which Soumille had done very nearly in the same way in the year 1746. (See *Machines et Inventions approuvées par l'Académie Royal des Sciences; tome xiii. p. 325.*) As there is no escapement wheel, a

further explanation is unnecessary to every one who has seen a treadle in action; but it may be necessary to remark that an additional wheel and pinion must be requisite in the train where the last pinion revolves more frequently than in other escapements.

40. *Escapement without a verge on the pallets by Ed. Maffey*.—Mr. Maffey's escapement without a verge was one of two escapements which together gained him twenty guineas from the Adelphi Society in 1803; the other, being of the 4th class, will be described in another place. *Fig. 5. of Plate XXXVI.* is a plan of this escapement, which is of a novel construction, borrowed probably from the spring detent escapement of the modern chronometers, and adapted to a clock, where the pendulum is free, during a large portion of its vibration. The pendulum rod is seen at *a*, suspended by a piece of watch spring in the usual way, but without a crutch and verge; *b* is the swing wheel with its teeth shaped like the dead-beat kind, except that they are rounded at the end; this wheel is not within the frame as usual, but on the outside of the back plate; *c* and *d* are the arms of the pallets *f* and *g* respectively; these arms are attached to the frame, and are adjustable for the included angle by the screws *b* and *i*, which press against the upper ends of the arms, that open like a pair of tongs, and are kept open by a slender spring *e* forced into notches at the ends. A cross bar *k*, carried by the pendulum, gives alternate strokes to the two pins fixed in the pallets *f* and *g*, at the time of unlocking. In the figure the pendulum is supposed to be in motion with the pin of pallet *g* resting against the cross bar *k*, which bar it impels on the returning vibration, and aids the pendulum, while the inclined plane of pallet *f* is raised by the wheel to give its stroke, when unlocked, in a contrary direction. Thus the pallets are raised partly by the wheel and partly by the pendulum, as is the case with Mr. Nicholson's pallets; for the spring in this case performs the same office that the weight does in that; but in this escapement the inclined planes must require oil, which is not necessary in the other, where the wheel acts by a direct push without any sliding motion. The inventor tells us, that a more than usually large maintaining power is necessary when this escapement is adopted, which indeed must be the case with all detached escapements, where the duration of the impulse is short.

The reader may have observed that we have not yet noticed in this article the fourth class of escapements which act by the aid of *remontoirs*; this omission has been intentional, not only for the purpose of avoiding the further enlargement of the article, but that we may give the history of the invention of the *remontoir*, and of its modifications by the different ingenious men, who have preferred its use to that of a detached escapement without such additional aid. We have already had occasion to speak of Harrison's and Mudge's auxiliary springs, or *remontoirs*, under our article CHRONOMETER, and it will suffice, for our present purpose, to name here that Huygens, Leibnitz, Gaudron, Haley, Breguet, De Lafons, Maffey, Mendam, Antis, and others have taken a part in bringing the *remontoir* into notice, as we shall have occasion to relate more particularly under the article REMONTOIR.

ESCARAY, in *Geography*, a town of Spain, in Old Castile; 5 miles S. of Calzada.

ESCARIGO, a town of Portugal, in the province of Beira; 12 miles N.W. of Penna Macor.

ESCARPE, or SCARP, in *Military Affairs*, relates to the exterior slope of each defence, while on the other hand the interior slope of every excavation beyond or facing the escarpe is designated the counter-scarp. It may be necessary to remark, that, in strictness, the term is not applica-

ble, except where some talus or slope is given to the exterior, though it is in very general and indiscriminate use. Originally, when the sides of hills, &c. were to be defended, it was found necessary to remove all such masses as might afford cover to an approaching enemy, or enable them to ascend to the assault; each rugged exuberance being in such cases adequate to the steps of a ladder, and offering a footing to the assailants.

To avoid this facility of attack, it became customary to chip away the prominent parts, and to render the surface inaccessible; this was effected by *escarping* it, (from the French verb *escarper*, to cut steep or sloping,) in such manner as to render it impossible for any one to ascend without the aid of ladders, &c.; giving at the same time a direct line of fire to the defenders, and enabling them to roll down stones, &c. with prodigious effect, upon such as should have the temerity to assault.

Latterly, however, the term has been applied to the exterior face of the works, whether the wall, or revetement, be inclined or perpendicular. Nor does the corruption stop here; for many are in the habit of calling the berm the *escarpe*, and of confounding the covert-way with the counter-scarp; whereas neither the *escarpe* nor the counter-scarp have any thing to do with the *terre-pleine*, or level ground; but are applicable solely to the inclined faces of the ditch and ramparts respectively.

It is true that modern engineers, who often allow their phraseology to follow custom rather than etymology, make little, if any, distinction between such revetements as are inclined, and such as are perpendicular: not that many opportunities exist for indulgence in this error; there being very few walls or revetements intended for military works, and especially for the faces of parts subject to be battered, which have not a talus equal to at least one-sixth of their respective heights.

In some fortresses less reliance is placed on the artillery mounted upon the several works than upon the advantages afforded by the inclination of the *escarpe*. Thus, where a fort or redoubt is built upon a conical mound of rock, of which the interior may be excavated for lodging the defenders and their supplies, if the face of the cone be every where *escarped* to an angle of about 40°, or more, from the horizon, a very moderate perpendicular, say to the depth of seven feet, around the summit, will prevent any assailants, however numerous, from carrying the place by storm; provided that perpendicular be properly manned and supplied with large stones, perhaps from twenty to a hundred pounds weight, which being rolled down the *escarpe*, invariably precipitate all who may be in the line of their descent; such a defence is not to be overcome so long as vigilance is maintained, and a supply of stones is at hand.

In India, (as well as in other parts of the world,) small forts are often *escarped* on this principle; there the stones held in preparation for defence, all along the interior of the parapet, are designated "*Mut-wallahs*," (*i. e.* drunken men,) in allusion to the manner in which they roll, and in which those whom they overset are tumbled down to the plain below.

ESCARS, in *Geography*, a small town of France, in the department of the Upper Vienne; 15 miles S.W. of Limoges, which, before the French revolution of 1789, conferred the title of count on the lords of the manor.

ESCARTELE', in *Heraldry*, quartered, or quarterly. See QUARTERING.

ESCATALENS, in *Geography*, a small town of France, in the department of the Lot; 6 miles W. of Montauban.

ESCATARI,

ESCATARI, a small island about 5 leagues N. of Louisbourg, in the island of Cape Breton.

ESCATRON, a small town of Spain, in the province of Aragon, above the confluence of the Martin and Ebro, nearly opposite to Rueda, between Saragossa and Mequinenza.

ESCAUT, THE, more generally known in England by its Flemish or Dutch appellation of the *Scheldt*, or *Schelde*, was formerly a river of Austrian Flanders, and is now a river of France, which gives its name to one of the northern departments. It has its source in the department of the Somme, near Beaufort, a few miles to the north of Saint Quentin, a town of the department of the Aisne; runs by Beauvoisi, Catelet, Homécourt, Crévecoeur, Cambrai, Houdain, Bouchain, Neuville, Denain, Valenciennes, Fraine, and Coudé, where it becomes navigable, after having received the Aisne; it then flows to Mortagne, where it receives the Scarpe; from thence it goes on to Tournay, Gand, and Antwerp, where it is 701 metres, or 360 fathoms wide, and 10 metres, or 30 feet deep at low water; the tide at high water rises 15 feet. After having passed Antwerp, the Escaut branches out into two channels; the eastern one passes by Bergen-op-Zoom, the west channel, called the Upper Escaut, loses itself between the islands of Zealand into the North sea, near Fleissingue or Flushing. From Antwerp to this place its course is 74 miles; it widens gradually, and has pretty nearly the same depth every where; but its bed is obstructed by sand-banks, which render its navigation difficult and dangerous.

The Escaut has a communication with the river Somme by means of a canal, part of which is under ground.

ESCAUT, *the department of the*, is the ninth department of the first region or United Countries (*pays réunis*) of France, and derives its name from the river Escaut (*Schelde*) which traverses it from south to north. It is composed of part of Austrian Flanders; its chief place is Gand. The limits of the department of the Escaut are to the north, the kingdom of Holland; to the east, the departments of the Dyle and of the two Nethe, from which it is separated by the Escaut; to the south, the department of Jemmapes, and to the west, that of the Lys. Its principal rivers are the Escaut, the Lys, the Durenne, the Lièvre, the Dender, &c.

There are several canals in this department; that which goes from Gand to Bruges, and from Bruges to Ostend, is the most important. Another towards the north opens a communication between Rodenherpen and Sao-de-Gand; a third one, near Morbeck, communicates by one of its branches with Axel, and by the other with Hullt. There are also several lesser canals for the purposes of irrigation, or of draining low marshy grounds.

The soil is in general fertile, and produces all sorts of corn and vegetables, chiefly hemp, flax, and hops. It abounds in game. Domestic fowls and sweet water-fish are plentiful. The chief manufactures are those of linen yarn, linen cloth, cobalt, Prussian blue, ribbands, woollen cloth, earthenware, glass, writing paper. There are also several paper mills, sugar-houses, salt-works, and bleaching grounds.

The territorial extent of the department of the Escaut is 2888½ square kilometres, or 159¼ square leagues; its population 595,258, or 3720 inhabitants to the square league. The whole department is divided into four districts, Gand, Audenaërd, Termonde, and l'Écluse; 41 cantons, and 338 communes. The average contribution of every individual to the expences of the state is about 9*s.* 2*d.* sterling annually. Herbin *Statistique de la France*.

ESCAUT and *Meuse*, *the department of the*, in Dutch the department of the Schelde and Maas, is one of the new divisions of the kingdom of Holland, and is reported to comprise the western part of the ancient Dutch Brabant, Zealand, and the islands of the Maas or Meuse. Middleburg is its chief place.

ESCH, a town of the duchy of Luxembourg, on the Sour; 7 miles W. of Dicrich.

ESCH, in *Ichthyology*, a name given by Hildegard and others to the fish we call the grayling, or umber, and the generality of authors, the thymallus. It is of the coregonous kind, and is distinguished by Artedi by the upper jaw being longer, and the back fin containing twenty-three bones. The Germans call it *asch*, and the Italians *temello*. See *SALMO Thymallus*.

ESCHALLOT, *Cepa Ascalonica*, in *Botany*, a species of onion, cultivated in gardens for its use in cookery, and nearly resembling the Welch onion. See *CEPA*.

ESCHAR. This term, in *Surgery*, implies a portion of flesh, deadened by the application either of actual fire or caustic substances. In cases of violent burns we frequently see eschars produced; and whenever we wish to make a common issue, for the relief of any such disease as a white-swellings, a caries of the vertebrae, &c. we cannot accomplish our object better, than by forming an eschar with the kali purum cum calce vivâ. The separation of an eschar, or its detachment from the living parts, is a work of nature, being chiefly effected by the action of the absorbent vessels, which remove the particles of matter, connecting the dead and living parts together, so as to loosen the eschar, and allow it to be taken away, without pain, bleeding, &c.

ESCHARA, in *Natural History*, the name of a species of coralline, &c. the characters of which are these: they are of a stony or coral-like hardness, and resemble a woven cloth in their texture; and the microscope shews us that they consist of arrangements of very small cells, whose surfaces appear much in that form. (See *MILLEPORA*.) For other species, see *FLUSTRA* and *MADREPORA*.

ESCHAROPEPA, a word used by the old writers in *Medicine*, to express a coarse kind of barley-meal, which had been torried over the fire.

ESCHAROTICS, in *Surgery*, are certain substances and applications which, when put on any part of the body, occasion an eschar, or slough. Although the strict meaning of the word escharotic is the same as that of *caustic*, yet, modern practitioners usually understand by the first term some application that is milder in its action, than such substances as are denominated caustics. By the latter, a surgeon generally means the kali purum, with or without quicklime, or the argentum vitriatum, antimonium muriatum, &c. But by escharotics he commonly implies applications like the cuprum vitriolatum, hydrargyrus præcipitatus ruber, &c.

The chief use of escharotics, in the practice of surgery, is to destroy excrescences, funguses, and high exuberant granulations. When mixed with ointment, so as to have their action weakened, they are also sometimes employed for stimulating sores, which are of an indolent nature.

ESCHATON, in *Music*, the difference between the diesis enharmonica and the hyperoché; that is, what remains, after taking the difference between the semi-tone minor and diesis enharmonica, from the latter. Hensling, in *Misc. Berlin*. vol. i. p. 279, 280.

Thus the difference between the semi-tone minor and the enharmonic diesis is  $\frac{25}{24} : \frac{128}{125} = \frac{3125}{3072}$ , and this taken from

from the diesis, is  $\frac{128}{125} : \frac{3125}{3072} = \frac{393216}{390625} = 6\Sigma - f + m$ , and is the *major residual*; which see. This interval is about  $\frac{53}{100}$  of a comma, as will easily appear by logarithms. Mr. Henfling has taken notice of this interval. He calls it *eschaton*, from its being the least and the last interval that occurs in his system.

The word is Greek, *εσχάτων*. See INTERVAL.

ESCHATON of Dr. Callcott's MSS., is an interval whose ratio is  $\frac{16,677,181, \&c.}{16,777,216, \&c.} = 5\Sigma + 2f$ , and is the *greater residual*, which see.

ESCHE, in *Geography*, a town of Switzerland, in the canton of Uri; eight miles S.E. of Altorff.

ESCHEAT, ESCHET, or *Ecbet*, formed from the French *escheoir*, or *échoir*, to happen, in *Law*, denotes an obstruction of the course of descent, and a consequent determination of the tenure, by some unforeseen contingency; in which case the land naturally reverts back, by a kind of reversion, to the original grantor or lord of the fee. (1 Feud. 86. Co. Litt. 13.) This was one of the fruits and consequences of feudal tenure: and is incident to tenure in socage, as well as to tenure in knight-service; except only in gavel kind lands, which are subject to no escheats for felony, though they are to escheats for want of heirs.

The civilians call such escheats, or forfeitures, *bona caduca*; and in the same sense, as we say the fee is escheated, they say *feudum aperitur*.

The word *escheata* sometimes also signifies a lawful inheritance descending on the heir. But then it is usually distinguished by the addition of *reita*; as *reita escheata*.

ESCHEAT is also used for the place or circuit within which the king, or other lord, hath escheats of his tenants.

ESCHEAT is also sometimes used for a writ, lying where the tenant having estate of fee-simple, in any lands or tenements holden of a superior lord, dies seised without heir, general or special: in which case the lord brings this writ against him that possesses the lands, after the death of his tenant; and thereby recovers the same in lieu of his services.

ESCHEATOR, an officer who anciently took care of the king's escheats in the county, and certified them into the exchequer, or chancery.

He was appointed by the lord treasurer; held his office only for one year; nor could any person be escheator above once in three years. But this office, having its chief dependence on the court of wards, is now out of date.

ESCHEFELD, in *Geography*, a small town of Saxony, near Wolfftitz, in the circle of Leipzick, remarkable for its quarries of beautiful jasper, known by the name of Bandstein von Gnadstein.

ESCHEL, in *Mineralogy*, a term used by the smalt-workers, to express a sort of grey substance resembling ashes, which is usually mixed with the smalt when in fusion. This is carefully separated from it before it is powdered for use, otherwise it would deface the colour. Phil. Transf. N<sup>o</sup> 396.

ESCHELLON, or ECHELLON, in the military acceptation, is a term borrowed from the French language, in which it signifies a ladder; alluding to the regular and parallel gradations of any series of lines, more or less inclined from any given base line. Thus if we suppose in *fig. 1. Plate I. Tactics*, the line A B to be divided into any given number of equal parts, as 1, 2, 3, 4, 5, 6, and suppose the left end of each division to be moveable on a pivot, the other end

swinging round at pleasure, we shall find that those several divisions are capable of being moved forward, at the assumed angles from the base line A B.

Now it is necessary to be well understood, that, according to the military step, the number of files from any given pivot will determine the number of paces to be taken to make a wheel, corresponding with a right angle: thus when the 8th file from the pivot makes eight paces in wheeling, the whole of the division performing such evolution will make a wheel equal to the quarter of a circle, because all distances from the centre must invariably correspond with the quarter of a circle, of which such distances are respectively radius.

But the echellon movements are never understood to amount to the quarter of a circle; that being considered a full wheel, changing from line into column: yet the echellon is itself a species of column, disposeable with equal promptitude either to flank or front; thus affording peculiar advantage, while it gives at the same time a parallel movement of a line, broken for the moment, into small portions, towards any object obliquely situated towards either flank; in front or rear. These important advantages have not been overlooked by modern tacticians, who have amply availed themselves of the mutability thus afforded: consequently we find the echellon adopted in the existing code of evolutions, on an unlimited scale.

It being ascertained that the eighth file, by moving forwards eight paces in a regular curve on the given pivot, makes a wheel of one quarter of a circle; it is obvious, that any intermediate part, of which one pace is the multiple, may be wheeled, by taking the desired number of paces; thus, four paces will make an octave, or the eighth part of a circle, which is the most frequent declination from the base line; two paces will give the sixteenth of a circle, or the fourth part of a quadrant; and thus of any number.

Let us suppose it requisite to change the front of a battalion to a new position, forming, as nearly as the eye could estimate, an angle of 75° from the base line A B. Now, as each step of the eighth file gives a change of front equal to about eleven degrees, it is obvious, that seven ordinary paces will rather exceed the given angle; therefore, if very great precision should be indispensable, the eighth file should make six long, and one short pace, which would throw the whole battalion into echellon at such an angle as would allow the several divisions to march with a full front to their positions in the new line. This is a most important object; because it admits the utmost freedom of individual movement, and avoids that oblique tendency which must be referred to whenever such full frontage cannot be preserved.

Echellon may be formed towards either flank; whether to the rear or to the front; the open column may be readily formed by wheeling so as to complete the quarter of a circle, including the original portion, and adding it to the supplement: both wheels being in the same direction. Thus if only the eighth of a circle was wheeled into echellon, another wheel, of another eighth, will be needful to bring the corps into open column.

To form the line from echellon; either a back wheel may be made equal to the wheel forward: thus, if a battalion has broken into echellon by wheeling an octave to the right, it will, by wheeling back an octave on the right of divisions, be instantly formed into line. In this instance the right flank gives the point d'appui. But if the left is to give it, there the whole of the divisions must wheel forward on their left pivots, as many degrees as were included in the original wheel to the right. If the first wheel was only the

16th part of a circle to the right, the complementary wheel to the left must be equal to only one sixteenth. In saying this, it is necessary to be understood, that all the divisions are supposed to be of equal strength; otherwise it will be indispensably necessary that the respective pivots, which are to guide the alignment, be properly dressed; that is, cover correctly, before any wheel is made under their guidance.

Echelon divisions do not always move with a full front towards that point on which the wheel is made; on the contrary, it is often expedient to wheel to the right, when the new front is towards the left. This is done for the purpose of giving the flanks of the divisions a proper direction, that they may respectively march by files, towards their stations in the new line; and is particularly necessary in broken ground, as well as in countries covered with wood. The several leaders of files must, in this case, be extremely correct in maintaining their original direction; attending to their several pivot-men, if such be in fight: where that guide cannot be afforded, the greatest care must be taken to observe any two distant objects that may be in the given direction; so as to proceed, as nearly as possible, to the appointed spot.

From the foregoing it will be collected, that, while direct changes of front are made by full wheels (*i. e.* the quarter of a circle,) to either right or left, oblique changes are effected by means of a due degree of parallelism, produced in consequence of wheeling in any proportion less than the quarter of a circle. Therefore, as the code of regulations now in use for the movements of battalions properly inculcates, the echelon position and movements are not only necessary and applicable to the immediate attacks and retreats of great bodies; but also to the previous oblique or direct changes of situation, which a battalion, or a more considerable corps, already formed in line, may be compelled to make, to the front or the rear, or on a particular fixed division of the line.

When a battalion marches in echelon its route must be on the reverse principles of Marquis's parallel rule, which consists of a scale, having a triangular piece sliding at liberty along its edge, as shewn in *fig. 2.* In that the inclined plane A B even follows a line not perpendicular to its front, and this is the main distinction between the echelon movement and the oblique-step; the former may continue for any distance, rather giving ease, than proving unusually fatiguing, to the men; whereas the oblique-step is peculiarly distressing, if kept up for a length of time; while it besides possesses the great disadvantage of gaining but little ground. In the above figure the line A B may proceed the whole length of C D, without gaining ground towards its opposite, or exterior flank B; because it is, in a manner, fixed by the inner flank A, which may be said to run in a groove on the line B C; whereas if we applied the echelon movement to the line A B, that is perpendicular to its own front, its course would be according to A E, B F, and ground would be gained to its right, as well as to its front, in exact proportion to the angle D A B; if that be small, there will be a greater tendency to the front of the line C D, than towards its left flank, and *vice versa*; ever carrying in mind, that so soon as the wheel amounts to a quarter of a circle, the term echelon is annulled.

We shall here exhibit the use of an echelon movement as applicable to the reinforcing of a line advancing at the *debouchure* of a *detroit*; where, in consequence of the regular expansion, it becomes necessary to keep adding to either, or perhaps to both flanks, in order to prevent the enemy from penetrating; so as to attack the rear. It may be expedient to observe that not only companies, but whole battalions,

may form in echelon; and that it is an evolution suited equally to cavalry and to infantry. When a park of artillery has to flank an enemy, in a position where the proper line cannot be assumed, so as to bring the several guns to a line perpendicular to the direction of their fire, they must then, properly speaking, be individually in echelon. Thus when guns are mounted in *barbet*, (*i. e.* where there are no embrasures, the muzzles traversing over the parapet,) whenever the object does not bear at right angles with the face of the battery, each gun is obliqued, and the shots fired from the whole would represent the movements of divisions thrown into echelon. *Fig. 3.* shews a line forming as the army issues from a *detroit*, the several battalions composing it being allowed to reinforce the centre until due space be gained for the whole to wheel into echelon. Now it will be seen, that each battalion formed in column, in by files, successively assumes a position perpendicular to that line; but, that when space admits, the wheel is made, whereby each division is directed towards the post it will occupy on the flank, as the expansion takes place. Here S S is the line, and O P the battalion destined to cover the right flank; its several divisions, being thrown into echelon, must in their progress fall into their respective posts, at the new position *a a* one after the other, filling up the augmenting space with celerity and exactness. It is, however, to be understood, that each, as it approaches its situation in line, must accelerate or retard its pace according to circumstances; since it cannot be expected that the ground will expand with perfect regularity.

In case of an attack, in which the enemy may succeed in getting round the flank, those divisions close to that flank must wheel back into line; leaving to two or three of the rear divisions to join on their flank in the direction of the echelon front; thus forming a re-entering angle, effectually cutting off the enemy's progress, and subjecting him to a concentrated fire; as shewn by the dotted positions at E. The dotted lines emanating from the several echellons shew their direction when marching: their prolongation would shew how they would fall in on the flank, so as gradually to extend the front; completing the new line *a a*. When necessary, the same operation is performed towards the left.

It has been observed that the eighth file gives a determinate measurement, in regard to the wheel of divisions into echelon; it is therefore expedient, when the given direction is ascertained, to cause the eighth file to step out the required distance, (say four paces for the eighth of a circle,) observing, that his advance must be on a wheeling principle: that is to say, curved; the pivot being considered as the centre, and the distance between that and the eighth file being radius. Each division thus sending forth its eighth file, the whole are ordered to wheel until those files are restored to their places in their divisions: during the wheel of the divisions, each must necessarily remain motionless; that all may dress by them; so as to give a true parallel throughout the line of echelon.

ESCHENAU, in *Geography*, a town of Germany, in the archduchy of Austria; eight miles S. of St. Polten.

ESCHENBACH, a town of Germany, in the circle of Bavaria, and Upper Palatinate; 34 miles E.N.E. of Nuremberg.

ESCHENBERGA, a small town of Germany, in the duchy of Saxe Gotha, with a population of 504 inhabitants, remarkable for its trade in madder. It was anciently of more importance.

ESCHERSHEIM, a town of Germany, in the circle of the Upper Rhine, and county of Hanau-Munzenberg;

10 miles W. of Hanau, and 3 N.N.W. of Francfort on the Main.

ESCHEVIN, or ECHEVIN, *Scabinus*, in the French and Dutch *Polity*, a magistrate elected by the inhabitants of a city to take care of their common concerns, the good order, conveniency, and décoration of the city, &c.

At Paris there is a *prevot* and four *eschevins*; in most other cities a *maire*, or *mayor*, and *eschevins*. In *Languedoc*, *Provence*, and *Dauphiné*, they are called *consuls*; at *Thoulouse* *capitouls*; and *jurats* at *Bordeaux*.

Anciently, the *eschevins* were the assessors and counsellors of the *comites*, or judges of cities; on which account they were called, in some places, *pairs*, *pairs*; they even took cognizance of petty causes themselves.

Du-Cange observes, that the judges, and their assessors, who were chosen by the inhabitants, were called *scabini*, *eschevins*, and their college, *scabinatum*, or *eschevinage*. He adds, that some authors call them *pacarii*, because their office and jurisdiction extended to the securing peace in their city and banlieue, called *pax villa*.

In *Holland*, the *scabins*, or *eschevins*, judge of all civil affairs at first hand. They also take cognizance of criminal matters; and if the criminal confess himself guilty, they can see their sentence executed without appeal. They can even give torture. The number is not the same in all cities; at *Amsterdam* there are nine, at *Rotterdam* seven, &c.

ESCHLBERG, in *Geography*, a town of Germany, in the archduchy of *Austria*; 14 miles S.W. of *Freustadt*.

ESCHLKAMP, a town of Germany, in *Lower Bavaria*; 3 miles E. of *Furth*.

ESCHRAKITES, or ESRAKITES, a sect of philosophers, among the *Mahometans*, who adhere to the doctrines and opinions of *Plato*.

The word is derived from the Arabic *شراک*, *schraha*, which in the fourth conjugation *شراک*, *aschraka*, signifies to shine, glitter like the sun; so that *Eschrakite* seems to import illuminated.

The *Eschrakites*, or *Mahometan Platonists*, place their highest good and happiness in the contemplation of the *Divine Majesty*; despising the gross imaginations of the *Alcoran* touching *Paradise*. See *MAHOMETANISM*.

They are very careful in avoiding all vice; they preserve an equal and easy temper, love music, and divert themselves with composing little poems, or spiritual songs. The sheiks, or priests, and the chief among the preachers of the imperial mosques, are *Eschrakites*.

ESCHWEGE, in *Geography*, a small town of Germany, in the *landgraviate* of *Hesse Cassel*, which now forms part of the new kingdom of *Westphalia*. It is situated on the *Werra*, 33 miles E. of *Cassel*, near a lofty hill called the *Meisner*, which has some coal-mines. *Eschwege* is a place of high antiquity.

ESCHWEILLER, a small town of France, in the department of the *Roer*, chief place of a canton, in the district of *Aix-la-Chapelle*, with a population of 1713 individuals. The canton has 18,588 inhabitants, dispersed in 28 communes.

ESCHYLUS. See *ÆSCHYLUS*.

ESCHYNOMENOUS PLANTS. See *ÆSCHYNOMENOUS*.

ESCLAIRCISSEMENT, or ECLAIRCISSEMENT, a French term, which we find retained in some late English writers; it properly signifies the act, or effect, of clearing a thing, or rendering it more bright and transparent; being formed from the verb *esclaircir*, to clear, &c.

It is chiefly used in a figurative sense, for an explanation of an obscurity or difficulty. The *esclaircissement* of difficult passages in the bible, is to be sought for from similar passages, or passages of the like kind occurring in other places.

ESCLAME, in the *Manege*, an obsolete French word, formerly used to signify a light-bellied horse.

ESCLATTE, in *Heraldry*, is applied to a thing violently broken. Thus a bend or rather partition, *esclatté*, is represented torn, or broken off, like a shield shattered with the stroke of a battle-ax.

ESCOBAR, ANTHONY, surnamed *D: Mendoza*, in *Biography*, a Spanish Jesuit, who flourished in the beginning and middle of the seventeenth century. The opinions which he maintained have been censured by more modern writers; and the principles of his morality have been exposed by *Paschal* in his "Lettres Provinciales," and by other authors of less note. He left behind him many works, among which are "Theologia Moralis;" "Commentaria in Vetus et Novum Testamentum;" and "Examen y Pratica de Confessores." Moreri.

ESCOL, in *Ancient Geography*, a valley or torrent of *Palestine*, in the southern part of the tribe of *Judah*; mentioned in the book of *Numbers*.

ESCORT, in *Military Affairs*, signifies that guard granted, either under military authority, or of military persons, for the safe conveyance of persons, property, &c. from one place to another. This may be said to distinguish an escort from a convoy; the latter being generally applicable to such extensive affairs as relate rather to the guarding of supplies, &c. on their way to an army, or to a fortress. The extent of an escort is usually proportioned either to the dignity of the person attended, if it be meant as a compliment; or, if of treasure, according to the sum, and the dangers lying in the way. In some cases, escorts are taken only from particular corps; as, for instance, those which attend upon his majesty, which are selected from certain regiments only, unless on extraordinary occasions. When an escort is employed on such an occasion, its commander is usually placed under the orders of the person to be guarded; but when treasure, prisoners, &c. are in question, the commander is in every respect paramount; he being responsible for the safe arrival, and the delivery, of whatever is under his charge. Such is the strictness with which the responsibility of an escort is upheld, that a few years back, when a deserter who was under charge of a guard made an attempt to abscond, one of the party fired at him, but unhappily missing the fugitive, killed an unfortunate passenger in the same street; the man who fired was considered to have done no more than his duty. We naturally view such an occurrence with much concern, and commiserate the sufferer; but when we contemplate what might have been the situation of the soldier, had he omitted to do his best towards preventing the escape, though we cannot exactly applaud his conduct, we must assuredly see much in extenuation of the manslaughter.

When travelling any distance, and that speed is essential, it is usual to relieve the escorts, when convenient, at certain stages. In such case, it behoves the commander of each party to be very careful in examining every matter previous to taking charge. If there be treasure, or other valuables, &c. under seal, the impressions should be minutely inspected; and if the articles, or packages, be numerous, but more especially if subject to damage, he should cause the whole to be counted, and ascertain, in the presence of the persons from whom he receives them, the exact state and appearance, noting every point worthy of observation in the way-

bill, and exclusively giving a receipt, in which all casualties or deficiencies should be fully described. This inspection should always be made in the presence of others of his own party, and it would not be amiss were he to cause them to attest the condition in which the articles should be, at the time of his receiving charge. Should any accident take place while under his own protection, the hour, the place, and the cause, ought to be in like manner noted, so soon as possible, under the certificate of credible persons on the spot; or at least of some of his own party. By such precautions much imputation will be avoided; while at the same time a character for correctness, and for assiduity, will be gained.

ESCOT, L', in *Geography*, a small town of France, in the department of the Lower Pyrenées; 6 miles S. of Oleron, remarkable for a cooling mineral spring.

ESCOUADE, or SQUAD, is usually the third or fourth part of a company of foot; so divided for mounting guards, and for the more convenient relieving of one another. It is equivalent to a brigade of a troop of horse. See BRIGADE.

ESCROL, or SCROLL, in *Heraldry*, a long slip, as it were, of parchment, or paper, wherein a motto is placed.

Leigh observes, that no person, under the degree of a knight, might, long after king Henry V. place his crest on a wreath, as is now usually done, but only on an escrol.

ESCROW, in *Law*, a deed delivered to a third person, to be the deed of the party making it upon a future condition when such thing is performed; and then it is to be delivered to the party to whom made. It is to be delivered to a stranger, mentioning the condition; and has relation to the first delivery. 2 Roll. Abr. 25, 26. 1 Inst. 31. See DEED.

ESCU, or ECU, the French crown, of sixty sols, or three livres. The escu was thus called, because the escutcheon, or arms of France, which they call escu, was struck thereon. See COIN.

ESCU, *Emaux de P.* See EMAUX.

ESCUAGE, or SCUTAGE, an ancient kind of knight's service, called also "service of the shield;" the tenant holding by which was obliged to follow his lord to the Scottish or Welsh wars, at his own expence. But personal attendance being inconvenient, the tenants compounded for it by a pecuniary satisfaction, which was levied by assessments at a certain rate for every knight's fee; and thus it became a pecuniary in lieu of a military service. The first instance that occurs was in 5 Hen. II. on account of his expedition to Toulouse; it afterwards became more general and oppressive; so that king John was obliged to consent, by his Magna Charta, that no scutage should be imposed without consent of parliament; but the clause was omitted in the charter of Hen. III. which directs, that it should be taken as it is used to be in the time of Henry II. or in a reasonable and moderate manner. However, it was afterwards enacted by stat. 25 Edw. I. cap. 5 and 6. and many subsequent statutes, that the king should take no aids or tasks but by the common assent of the realm; and it appears that scutages were the ground work of all succeeding subsidies, and of the land-tax of later times. Blackst. Com. vol. ii. p. 74.

ESCUAGE was also a reasonable aid, demanded by the lord of his tenants, who held of him by knight's service. See AID.

"Concesserunt domino regi ad maritandum filiam suam de omnibus qui tenent de domino rege in capite de singulis scutis 20 solidos solvendo." Matt. Paris, anno 1242.

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ESCOLAPIUS. See ÆSCULAPIUS.

ESCULENT, in *Gardening*, is a term frequently applied to such roots or plants as are replete with nutritious matter, and consequently proper for being eaten as a food. Carrots, parsnips, turnips, cabbages, and various others of a similar nature, are of this kind.

ESCULUS, in *Botany*, a name given by many authors to the phagus, or sweet oak, called also the esculent oak.

ESCULUS, or Æsculus. See ÆSCULUS.

ESCURA, in *Geography*, a province of the empire of Morocco, called by Leo Africanus *Afscora*, which, together with that of Ramna, formerly composed only one government. It has been divided to keep the people of these countries, so near to the mountains, more easily in subjection. Ramna and Escura have the province of Morocco to the south, that of Duquella to the west, the river Morbeya to the north, and mount Atlas to the east.

ESCURIAL, by the Spaniards written *Escorial*, a term that denotes the place of residence of the kings of Spain. Escorial originally signifies a little village in Spain, situated in the kingdom of New Castile, 22 miles to the N.W. of Madrid, on the side of a chain of mountains, called by some the Carpetane, or Carpentanian mountains, and by others the Pyreneans, as being the branch of the Pyrenean ridge, and environed by woodlands and green fields. Here king Philip II. built a stately monastery of the order of St. Jerom, held by the Spaniards for one of the wonders of the world; and called the Escorial. It was begun in 1557, and finished in about twenty-two years, at the expence of six millions of piastres.

Fa. Francisco de los Padros, in a description thereof, intitled "Description breve del Monasterio de S. Lorenzo el real del Escorial, &c." assures us it was built by that prince in memory of the battle of St. Quintin, gained on the day of St. Laurence, Lorenzo, a famous Spanish saint, and at his intercession; accordingly the plan of the work resembles a gridiron, the instrument of the saint's martyrdom.

The king and queen have their apartments there; the rest being possessed by the monks. Whence many of the great transactions of that court are dated from the Escorial.

This superb palace is a long square, 740 by 580 Spanish feet, besides 460 for what may be termed the handle of the gridiron. The height of the roof is 60 feet; and at every angle is a square tower, 200 feet high. In the west front there are 200 windows, and 366 in the east.

The Escorial has a very fine church, the dome of which is 330 feet, supported by four rows of pillars, and paved with black marble, containing 40 chapels, and 48 altars. To this church Philip IV. annexed a beautiful mausoleum, called the Pantheon, or Rotondo, built on the plan of that temple at Rome, 36 feet in diameter, and incrusted with marble; in which the kings and queens of Spain, who leave any posterity, are interred; the rest being laid in another vault of the same church, together with the infantas, and other princes.

The palace possesses every convenience and ornament that can render a place agreeable in so hot a climate; such as an extensive park, groves, fountains, cascades, grottos, &c. The adjacent country contains specimens of all the mineral substances, stones, earths and vegetables, which are found in other parts of the kingdom. The library belonging to this palace is said to consist of 30,000 volumes, contained in two magnificent apartments, each 19½ Spanish, or somewhat more than 182 English feet in length. In the lower room are chiefly printed books; and in this is deposited the

famous MS. of the four gospels, written in gold letters, said to be a work of the 11th century. Over these are collected 4500 MSS., of which 567 are Greek, 67 Hebrew, 1800 Arabic, the latter of which are well described in a catalogue published by Casiri. In the middle of the lower room is a temple, with a great variety of figures, containing 1448 ounces of silver, and 43 of gold, besides rich gems. In every part of the convent of the Escorial, are seen the works of the best masters, and some of them most capital performances. The best of the pictures are collected in five principal apartments; the great staircase is beautiful, adorned with fresco-paintings of the battle of St. Quintin, by Luca Jordano. The situation of the Escorial, as a residence, is not pleasant: exposed, as it is, to the full stroke of the meridian sun, and raised up near to regions covered with eternal snow; without shelter and destitute of shade, it has no local charms at any season of the year. (Townsend's Travels, vol. 2.) Part of this superb palace was burnt in 1671.

ESCUROLLES, in *Geography*, a small town of France, in the department of the Allier, chief-place of a canton, in the district of Gannat, with a population of 1042 individuals. It is 6 miles N. of Gannat. The canton contains 15 communes, and 11,408 inhabitants, on a territorial extent of 237½ kilometres.

ESCUTCHEON, or SCUTCHEON, in *Heraldry*, the field or coat, wherein the bearing, or arms, of any person are represented.

The word escutcheon is formed of the French *escuffon*, and that from the Latin *scutum*, shield; which was the place arms were originally borne on, before ever they came on banners; and still, wherever they are placed, it is on something representing the form of a shield. The Latin *scutum*, no doubt, came originally from the Greek, *σκιον*, leather, wherewith the shields were usually covered. See SHIELD.

The escutcheon is of a square figure, excepting the bottom part, which is usually a little rounded, ending in a point in the middle.

Till within a few hundred years, the escutcheons of the French and English were triangular; those of the Spaniards are still quite round at bottom, without any point; those of the Italians are oval; and those of the Germans in form of a catoozes.

The ancient escutcheons were generally couched, or inclined; and they only began to place them upright, when crowns, &c. were put over them by way of crest.

In France *escuffon*, escutcheon, was formerly restrained to a shield, or coat, pointed at bottom; by which it was distinguished from the *escu*, which was quite square, and was only allowed to be borne by the counts and viscounts. Those of the inferior quality were confined to the *escuffon* or pointed *escu*.

The several parts or points of the escutcheon have their proper names: the point A, for instance, is the dexter chief point; B the middle chief; and C the sinister chief point; D is the honour point; E the fesse point; F the nombril point; G the dexter-base; H the middle; and I the sinister base point. See *Plate of Heraldry*.

The dexter side of the escutcheon answers to the left hand, and the sinister side to the right hand of the person that looks on it.

The escutcheon is differently denominated, according to its divisions. It is called dextered, when the perpendicular line that divides it is to the right of a third part of the escutcheon; sinistered, when on the left; tierced in pale, when this line is double, and divides the whole escutcheon

into three equal parts; pale, when increased to the number of six, eight, or ten. A horizontal line makes the chief, when at one third part from the top; the plain, when at a third from the bottom; and when double, in the middle at an equal distance from both extremes, it makes the fesse, and the tierced in fesse: when it is multiplied, it denominates it fessed; when there are eight or ten equal spaces burrelle. A diagonal from the dexter point of the chief to the sinister of the base, makes it tranché; the contrary double; if it be double at equal distances the first makes bandé, and the tierce in bend; and the other barre, or tierce in bar; increasing the number of the first makes bandé, and cotticé; and increasing that of the second barré, and traverse.

ESCUTCHEON of *pretence*, is an *inescutcheon*, or little escutcheon, which a man who has married an heiress, and has issue by her, may bear over his own coat of arms, and in it the arms of his wife; and, in this case, the surviving issue will bear both coats quarterly.

ESCUTCHEON, in *Sea Language*, a name sometimes given to the compartment for the names or arms of the owner, or of the person whose title the vessel assumes. It is usually fixed on the middle of the ship's stern; and is more peculiar to the French, and other foreigners, than to English-built vessels. Falconer.

ESCUTCHEON, *Secret*, is a contrivance to be placed before a lock, which closes up, and conceals the key-hole, and renders it inaccessible for any person except the owner, who is acquainted with the secret.

The marquis of Worcester appears to have invented some secret escutcheons, for in his "Century of Inventions," published in 1663, at N<sup>o</sup> 72, after having spoken of three kinds of locks invented by him, says, "an escutcheon to be placed before any of these locks with these properties:

"The owner, though a woman, may with her delicate hand vary the ways of coming to open the lock ten million times beyond the knowledge of the smith that made it, or of me who invented it."

Many attempts have been made to form a machine equal in its properties to the description here given; and from thence, it is probable, arose the kind of padlocks which have been long made in this country, in great numbers, which having several letters on different rings, can only be opened when a certain set of those letters is arranged in one order; but this was in no degree equal to the end proposed; for besides the workman who made it, being at all times informed of the position the letters must be in, and consequently enabled to open it, the letters and rings admitting of no variation of place, at the will of the owner; reserving, at the same time, a power of opening the locks; whenever the proper arrangement became known, the secret was divulged, and all security at an end; but by the improvement lately made by Mr. Marshall (for which the Society of Arts rewarded him with ten guineas,) the letters or figures allowing an almost infinite variety of changes, the owner may, in one minute, alter the secret in such a manner, that even the maker would be as unlikely to open it, as he would be of gaining the highest prize in a lottery, by the chance of a single ticket. Thus this kind of escutcheon is infinitely more secure than any hitherto in use, especially as the alteration of the letters may be made every day for years, without recurring to their first state; and as the owner may at one time chuse to trust a friend, or a domestic with the secret, so that they might have recourse to his valuables, &c. he may also at another time wish to exclude them from that privilege, which this contrivance renders very easy to be done. As this improvement relates only

to the escutcheon, it is obvious that every attempt to pick the lock it covers, or to open it by means of false keys, is prevented; a circumstance of no small importance, when locks of a curious construction, and when a number of fine wards are made use of.

The escutcheon for which the bounty was given is reserved in the repository of the society for the inspection of the public.

*Figs. 2, 3, 4, 5, 6, 7, 8, and 9, Plate XII. Miscellany,* represent this contrivance: *fig. 3.* is a view from behind the machine, supposing it to be first removed from the door. *Fig. 2.* is an elevation of the machine, as it appears upon the door; A B C D is a brass box, fastened over the key hole; it has a square hole through it, covered by a small door E; this door is kept shut by a pin fixed into a small lever *a*, *fig. 3.* which enters a projection from the side of the door, and thus prevents it being open, unless the lever is first drawn back; a spring *b* is applied behind the lever to force it outward, and another at E always presses against the door, and acts to throw it open as soon as the lever *a* is drawn back, which is accomplished by means of a pin, which comes through a groove in the plate; this pin is fastened in a square bar F, *figs. 2 and 5.* (shewn separately in *fig. 4.*) on the front of the plate. The small perspective, *fig. 8.* represents two brass cocks *d, d*, which support the ends of a cylindric wire *g*, in which is a groove for the bar F to slide backwards and forwards; these cocks are screwed to the plate within-side, as shewn at *d d*, *figs. 2, 3, and 5,* and come through an opening in the Plate; so that the bar F is in front of the plate; the wire *g* is the common axis for five small rollers *a, c, f, m, o*, the structure of one of these is explained by *figs. 5, 6, 7, and 9;* *b* is a circular piece of brass which fits upon the centric wire: this, as is shewn in the sections, *figs. 5 and 9,* is thicker at the outside than the middle; and the front view, *figs. 6, 7,* shew how a recess is cut, communicating with the centre hole; now when the five rollers are turned round upon the central wire *g*, so that the recesses are all brought into the front, the projecting teeth *x, x*, of the slider F will meet with no obstruction, and may be drawn back so as to open the escutcheon; but when any of the rollers are turned round, so that the thin parts near the centre are brought between the teeth of the slider, then the slider cannot be withdrawn. The position of the roller, when the slider is at liberty, is known by bringing five of the letters which are engraven on the outside of the rollers uppermost, and it is in these letters that the secret consists. But to render the combination of letters variable, the letters are not engraven upon the outside of the rollers themselves, but upon a thin brass hoop *e*, which is fitted on round the roller; a spring *n* is fastened to the roller, and pressing upon the inside of the hoop causes such a friction, that they go together in general; but when the secret is to be changed, the slider F must be drawn partly back, so that its teeth *x* come in the way of the thin parts of the rollers, and they cannot, therefore, be turned round; the outside hoop *l* is then forced round upon the inside one, and a fresh letter brought opposite the recess; by this operation the secret is altered, and the escutcheon cannot be opened till the same combination is produced. Each roller has four letters upon it, in all twenty letters, and the combinations which they are capable of are so numerous, that the chance is strongly against any person not acquainted with the secret opening it.

ESCUTCHEON-grafting. See GRAFTING.

ESDEN, in *Geography*, a town of Germany; in the kingdom of Westphalia, and bishopric of Liege; 3 miles S.S.W. of Stocklin.

ESDRAELON, or ESDRELA, in *Ancient Geography*, a village of Palestine, in the tribe of Issachar, the same as Jezreel, 10 miles from Scythopolis, according to the old Itinerary. (Josh. xix. 18.) It gave name to a plain, which extended east and west from Scythopolis to mount Carmel; called likewise the "Great Plain," the "Valley of Jezreel," and the "Plain of Esdrela."

ESDRAS, See EZRA. We have four books of scripture under the name of Esdras; of which, only the two first are acknowledged as canonical; and they were formerly reckoned by the Hebrews as one, according to St. Jerom. The first of these is allowed to be the work of Ezra; for he relates events of which he was witness, and often speaks in the first person. Some, however, have supposed that the six first chapters were composed by a more ancient writer; and they allege, that the author of these chapters was at Jerusalem in the time of Darius the son of Hytaspes. (Ch. v. 4.) From this passage it is inferred that the writer was then at Jerusalem; but Ezra did not come thither till the reign of Artaxerxes, as appears by the beginning of the 7th chapter. To this argument it is replied, that Ezra speaks in the name of the Jews, and that it is usual for historians of a country to speak in the first person in the name of their own nation, although the historians themselves had no participation in the events which they record. Another difficulty occurs in explaining the genealogy and number of those who returned from Babylon to Jerusalem under Nehemiah, mentioned in the second chapter, and related in the same manner, though with some additions and alterations in the 9th chapter of Nehemiah. Some suppose that Nehemiah transcribed this out of the book of Ezra, adding the names of those persons who came to Jerusalem in the second return from the captivity. Others, on the contrary, imagine that Ezra copied the passage from Nehemiah, since mention is made in it of Nehemiah. Others pretend that the genealogy of Ezra was afterwards corrected from that of Nehemiah. However, none of these conjectures are reconcileable with the differences that occur in the two genealogies. But after all, there is no necessity for supposing that one of these authors transcribed from the other, for they might both of them have written these genealogies: Ezra having survived the second transmigration made under Nehemiah, and not having written his book till the latter end of his life. The second book under the name of Ezra, is attributed to Nehemiah; though some inconsiderable particulars have been added to it, which cannot belong to Nehemiah: such as the mention of the high-priest Jaddua, and king Darius. (Neh. xii. 22.) This Jaddua is Jaddus, in whose time Alexander the Great came to Jerusalem; and Darius is Darius Codomannus, overcome by Alexander 100 years after Nehemiah. The first of these two books contains the history of the deliverance of the Jews from the captivity of Babylon, and of their re-settlement in Judea, from the first year of Cyrus to the 20th of Artaxerxes Longimanus; and the second begins at the 20th year of the same prince, to the reign of Darius Nothus. The chronology of this space of time depends on the duration of the reigns of the kings of Persia.

The third book, under the name of Esdras, is thought by the Greeks to be canonical. Its author is not known, but he is supposed to have been an Hellenist Jew. The book is the same in substance as the first of Esdras, but interpolated; and in different parts of it we have a summary repetition of the two last chapters of the second book of Chronicles, as well as of the books of Ezra and Nehemiah. Against its authority there are several material objections, for which we refer to Arnald's excellent Commentary on the Apocrypha, p. 122.

The fourth book of Esdras is written with sufficient art, as if Esdras himself had composed it; but the marks of falsehood are discernible in it. Neither the Synagogues, nor the Greek or Latin church ever unanimously received it as canonical; though some of the fathers have cited it, and the Latin church has borrowed some words out of it. It is not now extant in Greek; and it never was in Hebrew. It seems most probable that the author was a Jew, converted to Christianity, who, in hopes of converting others, composed this work under the name of a writer, for whom the Jews had the highest esteem. And there seems good reason for concluding that the author lived in the times of the first heathen persecutions, from many passages encouraging faith, and a spirit of constancy under persecution.

ESEBON, a name given, by some of the chemical writers, to common sea salt.

ESENS, in *Geography*, a town of Germany, in the kingdom of Westphalia, and county of East Friseland; 24 miles N.N.E. of Emden.

ESFARAIN, a town of Persia, in the province of Chorasfan; 80 miles E. of Asterabat.

ESGÚEVA, a river of Spain, which runs into the Pisuerga, at Valladolid.

ESGUEYRA, or ESGUERIA, a town of Portugal, in the province of Beira, containing about 1600 inhabitants; 8 miles S. of Aveiro.

ESH, in *Rural Economy*, a term provincially employed to denote the ash-tree.

ESHANESS, in *Geography*, a cape on the west coast of Main-land, the largest of the Shetland islands. N. lat. 60° 38'. Long. 1° 7' E. of Edinburgh.

ESHCOL. See ESCOL.

ESHTAOL, in *Ancient Geography*, a town of Palestine, in the tribe of Dan, which belonged first to Judah. According to Eusebius it was 10 miles distant from Eleutheropolis, towards Nicopolis.

ESHEMOTH, a city in the south of Judah, which, according to Eusebius, was a large town in the district of Eleutheropolis, north of that city. It was ceded to the priests. 1 Chron. vi. 57.

ESI, in *Geography*, a town of Italy, in the state of the church, and marquise of Ancona; 11 miles S.S.W. of Ancona.

ESK, SOUTH and NORTH, rivers of Scotland, which descend from the Benakinnan mountains on the north border of Angus. The former runs S.E. and E. by Cortachie, Tannadyce, Brechin, and falls into the German ocean below Montrose, to which town it is navigable from the tide-way in the German ocean. (See CANAL). The direction of the latter is E. and S.E. through a narrow valley, till it reaches the strath lying between the Grampians and the sea. In the lower part of its course it forms the common boundary of Angus and Kincardine.

ESK, a river in Cumberland, which is navigable from the Solway firth up to the town of Longton.

ESKARMAKRUN, a town of Persia, in the province of Chusistan; 90 miles S. of Susa.

ESKE, a river in the East Riding of Yorkshire, which is navigable only from the sea up to Whitby-bridge. See CANAL.

ESKE, a river in Cumberland, which is navigable from the sea near Ravenglass to Mulcafter. Near to Ravenglass it is joined by the Irt river.

ESKER, a river of European Turkey, which runs into the Danube; 20 miles W. of Nicopolis.

ESKI-BABA, a town of European Turkey, in Romania; 30 miles S.E. of Adrianople.

ESKIER, a town of Arabia, in the country of Yemen; 60 miles N. of Aden.

ESKIJALFA, a town of Persian Armenia, in the country of Erivan; 120 miles S. E. of Erivan.

ESKI-HISAR, a town of Asiatic Turkey, in the province of Natolia; 16 miles W. of Mogla.

ESKI-HISSAR, a town of Asiatic Turkey, in the province of Natolia, formerly Laodicea, now almost a heap of ruins; 8 miles N. of Degnizlu.

ESKIMAUX, or ESQUIMAUX. See ESQUIMAUX and LABRADOR.

ESKIMAUX Bay, a bay on the south-coast of Labrador. N. lat. 51° 30'. W. long 57° 50'.

ESKIMAUX Islands, a cluster of small islands in the gulf of St. Lawrence, near the south-coast of Labrador. N. lat. 50° 15'. W. long. 63°.

ESKISADRA, a town of European Turkey, in the province of Romania; 48 miles E. of Filippopoli.

ESKISHEHR, a town of Asiatic Turkey, in the province of Natolia, on the river Sakharra; 116 miles S.E. of Constantinople. N. lat. 39° 48'. E. long. 32° 58'.

ESLA, a river of Spain, which runs into the Duero, between Zamora and Miranda de Duero.

ESLINGEN, a town of Germany, in the circle of Suabia, which, till the peace of Luneville, was a free imperial city. It now belongs to the king of Wirtemberg, and is situated on the Necker, 30 miles N. E. of Tubingen, and 6 miles S. E. of Stutgard.

ESMONA, or AZEMONA, in *Ancient Geography*, a town of Arabia Petraea, which was one of the stations of the Israelites in the Desert. The book of Joshua ascribes it to the tribe of Juda, so that it is probably the same with *Esem*.

ESMOUTIER, in *Geography*, a small town of France, in the department of the Upper Vienne; 21 miles E. of Limoges.

ESNA, in *Ancient Geography*, a town of Palestine, in the tribe of Juda. Josh. ch. 15.

ESNECY, *Æsnecia, dignitas primogeniti*, in *Law*, a private prerogative, allowed to the eldest coparcener, where an estate has descended to daughters for want of heirs male, to chuse first after the inheritance is divided. Fleta, lib. v. cap. 10. "Jus esnecie is jus primogenituræ," in which sense it may be extended to the eldest son, and his issue, holding first. In the statute of Marlbridge, cap. 9. it is called "initia pars hereditatis."

ESNEH, *Èsné, or Asna*, in *Geography*, one of the most important towns in Upper Egypt, seated on the left of the Nile, in N. lat. 25°. E. long. 49° 15'. This town is governed by an Arabian prince and by a Cachef, dependent on the Bey of Girgé. The Mahometans have several mosques here, and the Copts a church, that is served by two priests. According to the description of Abulfeda, which corresponds in a great degree to its present state, Esné is remarkable for its public baths and its commerce: it is built on the westward of the Nile, between Assuan and Cous, but nearer to the latter. The Copts are said to be its founders. The well-cultivated territory abounds in grain and palm-trees. Situated on the edge of a rich country it is shaded by groves of orange-trees loaded with fruits and flowers, and immediately surrounded with gardens amply stocked with fruit-trees. It presents to view several ancient monuments constructed by the Copts, and superb ruins. This town, formerly called *Latopolis*, revered Minerva and the fish *Latus*. (Strabo, l. 17.) It contains within its boundary an antique temple, enclosed on three sides by thick walls. Six large fluted columns, crowned by a capital, ornamented with the palm leaf, form the façade of it; eighteen others support the roof; which is

composed of large squares of marble; the building is surrounded by a frieze, and innumerable hieroglyphics cover its exterior aspects. Those of the inside, executed with greater care, mark the progress made by the Egyptians in sculpture. These hieroglyphics contain, among other subjects, a zodiac and large figures of men with crocodiles' heads; the capitals, though all different, have a very fine effect; and as an additional proof that the Egyptians borrowed nothing from other people, it is remarked, that they have taken all the ornaments, of which these capitals are composed, from the productions of their own country, such as the lotus, the palm-tree, the vine, the rush, &c. The portico of this temple is represented by M. Denon, (*Travels in Egypt*, vols. 2. and 3.) as the most perfect monument of ancient architecture. Denon has given a plan and elevation of this portico, and delineated the varieties of its capitals, and part of the sculptures on the ceiling; but he was surprised that, after all his research, he could find no representation of the fish *latus*, from whose name the town was called *Lato-polis*. At present this temple is soiled by the ordure of the cattle kept there by the Turks, who convert the most beautiful monuments of ancient Egypt into stables. About a league to the west of Efné is another temple, on the walls of which is carved in several places a woman seated, representing an Egyptian deity called "Neith," to whom the ancient Greeks gave the name of Minerva. The columns of this temple, as some have conjectured, gave to the Greeks the idea of the Corinthian order; the capitals being ornamented with a foliage very much resembling the Acanthus. Several animals painted on the ceiling have preserved their colours. To the south of Efné are seen the ruins of a monastery founded by St. Helena, and near it the burying place of the martyrs, adorned with tombs crowned by cupolas, supported by arcades. The inhabitants of Efné having revolted against the persecution of Dioclesian, this emperor destroyed the town, and put them to the sword. This place, consecrated by religion, is become a celebrated pilgrimage among the Copts, who repair hither from the most distant provinces of the kingdom. In the chain of mountains, which stretches to the eastward of the Nile, and nearly opposite to Efné, are quarries of a soft stone, called "Baram," which hardens in the fire, and is used in the manufacture of kitchen utensils. Savary's Letters, &c. vol. ii.

ESOCHE, from *εως*, within, and *εξ*, to have, in Surgery, a tubercle within the anus.

ESOPUS. See KINGSTON.

ESOTERIC. See EXOTERIC.

ESOX, in *Ichthyology*, a genus of the abdominal kind, distinguished by the following essential particulars. The head flattish above; mouth and throat large; jaws toothed, unequal, the upper one flat, lower punctated; tongue broad, loose; palate smooth; eyes round, moderate size, and lateral; nostrils double, near the eyes; gill-covers large, aperture ample, with from seven to twelve rays; body elongated, covered with hard scales; above convex, and compressed at the sides; lateral line straight, nearest the back, and scarcely visible; dorsal and anal fin very short, and generally placed opposite.

#### Species.

LUCIUS. Snout depressed; jaws nearly equal. Linn. *Fn. Suec. Art. Gen. Rondel. Brochet*, Bell. *Pike*, Penn. *Donov. Brit. Fishes*.

The pike is an inhabitant of most of the lakes of Europe, and the north of Asia, and also of many of the larger rivers in Lapland, Siberia, and countries adjacent. It grows to a considerable size, those of four or five feet in length not

being uncommon in the northern regions, and sometimes even they attain to the length of eight feet or more. The pike is highly prolific, and from its extreme voracity as well as cunning, is called the wolf, or the fox of fishes; it subsists on fishes, on frogs, serpents, and other reptiles, and on the young of swans and other aquatic fowl, and is reputed so undaunted in its attacks that it will even contend with the otter for its prey. This fish spawns in spring between the months of February and May. The colours vary in brightness at different seasons; in general the upper part is olivaceous green, with the back nearly black, and the whole spotted with yellow, whitish, or orange, according to the health of the fish. The belly white, and the fins beautifully variegated with vivid colours and spots of blackish purple. The jaws contain a formidable armament of teeth disposed in longitudinal rows. The longevity of the pike is well known to be very great; but what credit ought to be repoted in the assurances of some writers, that it lives to the age of two or three hundred years, must remain for others to determine. Their multiplication is immense; in the northern parts of Russia, and in Siberia, where they are taken in the greatest plenty, they constitute an article of commercial importance, being prepared by means of salting and drying, for exportation.

VIRIDIS. Green; lower jaw longer, scales thin. Gmel.

This is regarded by Bosc as a variety only of the common pike, (*Esox lucius*), the accuracy of which opinion appears rather uncertain, as we may perhaps be unacquainted with the species or fish intended by Gmelin; the reference of the latter author to the *Acus maxima squamosa viridis* for the same fish is supposed to be incorrect.

SPHYRÆNA. Dorsal fins two, the first spinous. Linn. *Arted. Sea pike or Spit-fish*, Charl.

There is some remote resemblance between this fish and the common pike, from which among other particulars it is distinguished by having the lower jaw advanced, the body more slender, the tail furcated, and the back furnished with two dorsal fins instead of one. The rays of the first dorsal fin are spinous, and are described both by Linnæus and Artedi as five in number, but according to Bloch these amount to only four. The fish is blueish above, beneath white; the pectoral, ventral, and anal fins red. It grows to the length of two feet, and inhabits the Atlantic and American seas. The flesh is in esteem.

The Barracuda pike of Shaw's *Gen. Zool.* described after Catesby, appears very closely allied to the preceding, if it be not the same; the character "brown, elongated, whitish beneath, with two dorsal fins and forked tail," differs from that fish only in having the upper part brown instead of blueish. It is found in the West Indies, and grows to the length of eight or ten feet.

BECCUNA. Silvery-blueish, marked on each side by a row of deep-blue spots, with two dorsal fins, and forked tail. Shaw. *Gen. Zool. Sphyræna beccuna*, Cope.

This accords so nearly with the *Esox sphyræna* that we cannot suppress our suspicions of its being the same. The only authority on which it is described is a drawing by Plumier; this, indeed, represents a fish of somewhat more elongated form, in which the sides are marked with a series of blue spots not observable in the former. If it prove distinct it is certainly very analogous. It is described as a native of the American seas.

AUREO-VIRIDIS. Body golden-green, with two dorsal fins, a spine before the first; lower jaw longer. *Sphyræna aureo-viridis*, Cope. *Gold-green pike*.

Described and figured by Cope from the drawings of Plumier; the body is deep, as in the sparus, the head sharp pointed;

pointed; scales middle sized; tail forked and lunated. The species inhabits the American seas.

**VULPES.** Dorsal fin in the middle of the back; the gill membrane three-rayed. Gmel. *Vulpes bahamensis*, Catesby. *Fox pike.*

Resembles the common pike, but is more slender in proportion towards the tail, the colour brown above, beneath paler. Native of Carolina and the West Indies.

**SYNODUS.** Dorsal fin in the middle of the back; gill membrane five-rayed. Gmel. *Synodus*, Catesby.

Closely allied to the former, and inhabits the same seas, and according to Cope the Mediterranean also. The body is marked with dusky bands; abdomen silvery; fins striped with black.

**HEPSETUS.** Lateral line silvery. Gmel. *Argentina pinna dorsali pinnae ani opposita*, Linn. Amœn. Acad. *Piquitinga*, Maregr. Inhabits America.

**MARGINATUS.** Dorsal and anal fins opposite; lateral line silvery; lower jaw six times as long as the upper. Forsk. Fr. Arab.

This and the preceding are supposed to be the same. The latter is described by Forskal as an inhabitant of the Red sea; its length about a span and a half; the body linear, tapering each side, and covered with broad lax, entire scales, the colour brown above, beneath white; the anal fin small, triangular, glaucous, and yellow without; dorsal yellow externally; tail bilobate, the upper lobe pale yellow, the posterior edge brown.

**CHINENSIS.** Head slender, lower jaw longer; eyes large and protuberant. *Sphyrana chinensis*, Cope.

Slightly described by Cope from the manuscripts of Commerçon as a native of the Indian seas. The general colour is said to be green with a silvery hue, and the scales of the middle size.

**CHILENSIS.** Jaws equal; lateral line blue. Molina. *Chili pike.*

Native of the Chilese seas. Length from two to three feet; body round, covered with bony angular deciduous scales, above golden, beneath silvery; flesh white, and excellent.

**ARGENTEUS.** Brown variegated with yellowish characters. Gmel. Forster, &c. *Silver pike.*

Inhabits fresh waters of New Zealand and other islands of the southern ocean.

**BRASILIENSIS.** Lower jaw very long; body serpentine. Linn. Mus. Ad. Fr.

These are several figures of this fish in different authors, most of which are defective in one particular or other. Nieuhoff omits the anal and ventral fins, Valentyn and Renard constitute two species of the same fish; and in other representations the dorsal fin is omitted. Linnæus erroneously refers to the Timucu of the Brasilians as being synonymous; the fish so named by these people has both the jaws elongated, and ending in a point, and is supposed to be the species Belone. Gmelin adopts the same misreference. The length of this fish is from twelve to fifteen inches; the upper part of the body green, beneath yellow, and the back marked with about six broad and equidistant bands of fuscous. The species inhabits the Brasils, and is esteemed a delicacy for the table.

**GYMNOCEPHALUS.** Jaws equal; gill-covers very obtuse; head naked. Linn. *Naked-headed pike.*

Native of India, according to Linnæus, who speaks of it as being the size of the sand lance.

**MALABARICUS.** Two canine teeth in each jaw; gill-membrane with five rays. Bloch.

Found in the rivers of Malabar. The length is about

twelve inches; its form somewhat resembling that of the common pike. The colour above greenish-blue, beneath yellow; fins yellow; at the base purplish, and marked with several distinct bands of brown. The lower jaw is rather longer than the upper, and the tail is rounded.

**CHIROCENTRUS.** Breast armed on each side by a spine over the ventral fin; lower jaw longer. Cope.

Described from the manuscripts of Commerçon. Its form resembles in some respects that of the common pike. The spine is said to be strong, and slightly curved; its length about two-thirds that of the fin, of which it appears to be the first ray.

**BELONE.** Each jaw long and subulate. Gmel. *Sea pike, gar-fish, or sea needle*, Penn. Donov. Brit. Fishes.

Length from eighteen inches to three or four feet, of a very slender eel like form, with long projecting snout, the back fine green; belly silvery. It is a common species in all the European seas; migrating annually in large shoals from the depths of the ocean to the shore. They appear on our coasts in the spring, commonly announcing the arrival of the mackerel, but remain with us for a much shorter period than that fish. They deposit their spawn close to the shore among the rocks and sea weeds, where the young are hatched, and after a certain time retire. We have seen the fry of this fish on our coasts during the summer months. As an article of food the gar-fish is held in far less estimation than the mackerel, to which its flavour in some degree approaches. By many people the flesh is considered unwholesome, and even poisonous; arising, no doubt, from the singular circumstance of the bone becoming of a fine grass green colour in boiling. This species grows to the length of eight feet. Donov. Brit. Fishes.

**SAURUS.** Jaws subulate, and slightly curving upwards, lower one longest; above and beneath spurious fins near to the tail. *Maxillis subulatis suascentibus, inferiore longiore, caudam versus supra infraque pinnulis spuris.* Donov. Brit. Fishes. *Saurus*, Rondel. *Skipper*, Ray. *The jaury*, Penn. &c.

The obscurity that prevailed respecting this curious fish till within a very recent period, induced us to enter on the details of its general description with rather more than ordinary minuteness: the writer of this article has already treated at some length on the *Esox saurus* in his work on British fishes lately published, and conceives a repetition of the following observations submitted on that occasion may net prove altogether unacceptable.

Our countryman Ray appears to be the first writer who describes this rare and curious species of esox as a native of Britain; he speaks of it as a Cornish fish, under the provincial name of skipper. Rondeletius and Gesner previously mention it as a scarce kind among the fishes of the Mediterranean. In 1769 the same fish was again introduced to notice by Mr. Pennant in his tour of Scotland, and afterwards in his British Zoology, wherein we are informed, that vast numbers of them were thrown ashore on the sands of Leith, near Edinburgh, after a great storm in November, 1778. In the summer of 1800 a single specimen was taken near the isle of Portland, in Dorsetshire, after a hard storm; an account of which, accompanied with a figure of the fish in its natural size, is given by the Rev. Mr. Rackett, in the third volume of the Linnæan Transactions. "This fish (Mr. Rackett observes) appears to be rare on the Dorset coast. Of the fishermen in this part, only one was acquainted with it, and called it a skipper, the name under which, according to Ray, it was known in his time on the coast of Cornwall. This writer adds that the species has not been noticed by Linnæus, Gmelin, nor Bloch; and that Pennant

nant has given a very indifferent figure of it in his *Tour in Scotland*, and has made use of the same plate in his *British Zoology*." See Linn. *Trans.* 3. p. 60.

It is altogether singular that this fish has no place in either edition of the *Linnæan Systema*, not even that by Gmelin; it is inserted by Dr. Turton in his translation on the authority of Pennant. The length of this species is about eighteen inches: the body of a long and slender form; not like that of an eel, as writers describe, but agreeing precisely with that of the common gar-fish (*Esox belone*). The snout is subulate, fine, toothless, and curving upwards. The jaws are of unequal length, the lower being longest, and bending upwards at the tip, in which respect it differs from the figures of Mr. Pennant and Mr. Rackett, in both which the jaws appear straight and of equal length. Neither do the jaws, when closed, exhibit that remarkable hiatus or gaping shewn in those two representations; there is a kind of flexuosity in the shape of the mouth, when open, which might excite such an idea, but upon gently closing it the curvature in the form of one jaw will be found to correspond with the figure of the other; so that the character "maxillis medio hiantibus," assigned to it, is by no means applicable. Dr. Shaw mentions in the *Gen. Zool.* that "in a specimen figured in the work of Cope, the jaws are represented upwards, contrary to what has hitherto been observed; the specimens figured in the work of Mr. Pennant, as well as that of Rondeletius, and the drawing by Mr. Rackett, have the jaws straight." This is certainly true, and it is therefore to be presumed that the examples from whence the figures of the latter mentioned writers have been taken must have sustained injury, or been misrepresented; for it is clear Cope is right in representing the jaws curving upwards: it is indeed evident, from the comparative shortness of the jaws in the figure by Pennant and others, they could not be perfect, the beak in the fish itself being nearly twice the length delineated by either. Dr. Shaw has also been apparently misled to the persuasion that the skin of this fish is reticulated by fine fins decussating each other at equal distances, which is not by any means the natural appearance of the fish, and the figure in the *British Zoology* is still more erroneous, as it appears entirely smooth, and destitute of scales.

Some misunderstanding seems to prevail likewise as to the colour of the fish. Mr. Pennant describes it as having the back dusky, and the belly bright and silvery, in which particulars he is followed by Dr. Shaw, who remarks that the colour of the whole animal is dusky above, and silvery beneath, with dusky or blueish brown back. This is not, however, correct, the true colour of the back of the fish is a most lovely azure blue, changeable to green, and glossed with purple and yellow, and the lower parts silvery. The body has a smooth appearance, the scales with which it is covered being thin and glabrous: the lower part of the body from the gills to the tail is marked with a longitudinal carina or keel, which terminates at the latter part in a somewhat protuberant manner.

The species may be readily distinguished by the pinnules or spurious fins on the body near the tail, in which particular it agrees with the scomber or mackerel genus; these have been variously misrepresented; in the fish itself they amount altogether to twelve in number, five of which are disposed above and seven beneath; and it is also necessary to add that they are perfectly detached from each other. The fish, in point of flavour, resembles that of the mackerel.

*CASSEUS*. Upper jaw longer; scales bony. Linn. *Esox maxilla superiore cauda quadrata*, Arted.

Native of North America and Asia, and has been found

in Europe. (Donov. *Brit. Fishes*.) The species is from two to three feet in length, and is covered with rhombic scales.

*CEPEDIANUS*. Snout long, jaws spatulate; scales bony. *Le pisosteus spatula*, Cope. *Esox cepedianus*, Shaw.

The principal difference between the two last mentioned fishes seems to consist in the snout being shorter in proportion in *E. cepedianus* than the other. There is likewise another pike of the same bony scale kind, which has the jaws rather shorter than either, and bears the name of *Leve-rianus*. We are not entirely satisfied that the three last mentioned differ specifically from each other.

No small degree of uncertainty seems to prevail throughout this tribe of fishes independently of those last adverted to; the species *synodus*, *hepsetus*, *vulpes*, and *marginatus*, appear to be imperfectly understood: *barracuda*, *viridis*, and *becuna*, are perhaps more doubtful, as are also *chiro-centrus*, and *chiensis*; and it will have been observed that the true characters of the species *saurus* were not till lately ascertained.

The viper-mouthed pike (*Esox stomias*), and *vipera marina* of Catesby, is distinguished by having four of the teeth much larger than the rest: this is a very extraordinary fish, and ought, in our opinion, to constitute a new genus.

*ESPADACINTA*, in *Geography*, a town of Portugal, in the province of *Tras-los-Montes*, situated on the *Duero*, and borders of Spain; 34 miles S.W. of *Miranda de Duero*, and 28 N. of *Almeida*.

*ESPAGNAC*, JOHN-BAPTIST-JOSEPH DE SAHUGUET-DAMARZIL, BARON D', in *Biography*, a military writer, was born in the year 1713 at *Brive-la-Gaillarde*. At the age of nineteen he entered the army, and became celebrated for great skill and prowess. In 1742 he was aid-de-camp in the war of *Bavaria*, and was afterwards employed by *Marshal Saxe* as aid-major general and colonel of a regiment of grenadiers. In 1780 he was raised to the rank of lieutenant-general, and died at *Paris* in 1783. As an author he attained a good share of celebrity by his "Campaigns of the King in 1745-48," which were published in four octavo volumes. He published also "Essays on the Science of War," 3 vols. 8vo. "An Essay on the great Operations in War," in 4 vols. 8vo; "A Supplement to the Reveries of *Marshal Saxe*," in 2 vols. 8vo. 1773. He likewise drew up "The History of *Marshal Saxe*," in 3 vols. 4to. in which are detailed plans of his battles and marches, together with those particulars of the life of that general, as render it a work of considerable interest to literary as well as to military men." *Nouv. Dict. Hist.*

*ESPAGNAC*, in *Geography*, a small town of France, in the department of the *Lozere*; 12 miles S. of *Mende*.

*ESPAGNE*, JOHN D', in *Biography*, a French protestant divine in the seventeenth century, was born at *Dauphiné*, and became minister of the French church in *London*, an office which he sustained during the reigns of *James I.* and *Charles I.* He published several small tracts, which were afterwards collected and published at *Geneva* and the *Hague*, in three and in two volumes 12mo. about the year 1670. He also published a work, which he dedicated to *Charles I.*, entitled "Erreurs Populaires en points Généraux qui concernent l'Intelligence de la Religion." Of this and of some other of his pieces *Bayle* speaks in terms of commendation. *Moreri*. *Bayle*.

*ESPAGNE*, in *Geography*. See *EPAIGNE*.

*ESPAGNET*, JOHN D', in *Biography*, who flourished in the 17th century, was president of the parliament of *Bourdeaux*. As a literary character he published a work entitled "Enchiridion Physicæ Restitutæ," which was afterwards

wards translated into French under the title of "La Philosophie des Anciens retablie en sa Pureté." This may be regarded as the first book that appeared in France, in which there is a complete system of physics contrary to that of Aristotle; though the author pretended that he had merely re-established the ancient philosophy. He published also a work concerning the philosopher's stone, entitled "Arcanum Hermeticae Philosophiæ Opus." Also an old MS. entitled "Le Rozier des Guerres," found at Nerac in the king's closet, and attributed, though erroneously, to the pen of Lewis XI. To this work he added a treatise of his own, upon the education of a prince. In publishing the "Rozier des Guerres," he followed the original with the utmost exactness, because, says he, "this little tract seemed to me so good, that I would not embellish or disguise it, but have left it in its native simplicity: and though the language of it is not in use in this age, yet it may be understood, being so full of good sense and meaning, that with all its jargon it may silence the affected language of the court and bar. I have also carefully preserved the spelling, because in adding or diminishing a letter, a word is often changed, and of old made new." Bayle.

ESPAIN, SAINT, in *Geography*, a small town of France, in the department of Indre and Loire; 15 miles S.E. of Chinon.

ESPALIER TREES, in *Gardening*, are such fruit trees of low growth as are trained to treillages or framed wood-works made for the purpose, in ranges, so as to constitute a sort of hedge. They are usually planted in single rows along the borders, on the sides of the principal walks, in the main divisions of the garden, affording shelter to other plants as well as ornament to such parts.

The sorts of fruit trees mostly employed in this way are those of the apple, pear, and plum kinds; but many others may be managed in this method where variety is wanted; as the quince, cherry, almond, apricot, mulberry, and filbert. And it is necessary, with a view to beauty and uniformity, to manage them in such a manner as to have them that are nearly of the same growth in the same range or line of planting.

The sorts of apples most adapted to this use are those of the golden and other pippin kinds, the nonpareil, rennet, and russet; but many others may be cultivated in this way.

In the pear-kind, the jargonelle, blanquette, bergamot, burre du Roy, &c: the melting pears being always better in this way than those of the breaking kind. On strong moist soils those grafted on quince stocks are the best, but on dry ones those on free stocks.

Trees intended for this use should be grafted or budded within a few inches of the surface of the ground, that branches may be thrown out regularly from the bottom upwards, to furnish and fill the treillage; and the more effectually to accomplish the purpose, the first shoots from the grafts, &c. should be cut off, or headed down within a few inches of the grafts, in the spring season, when they have had one year's growth. The branches or shoots thus produced, whether the trees are in the nursery, or planted out as espaliers, should, in the latter part of the summer, or beginning of autumn, be trained both ways laterally in their advancing growth, to stakes put down for the purpose, or the espalier frames. In this way the trees acquire a proper form, those in the nursery being thus trained and kept for sale. A second heading down in the upper branches may likewise be practised when necessary, in order to fill up the middle, and completely cover the frames.

When these trees have been thus trained for three or four years in the nursery-ground, they are generally in a

proper situation for being planted out as espaliers in the borders or other parts along the sides of the walks in the garden or pleasure ground, a sufficient breadth being allowed for the borders according to the size or extent of such grounds, as six, eight, ten, or more feet.

Besides this, there is another method sometimes practised in forming espalier trees, which is that of, after heading the first shoots down as above, training the side-shoots horizontally in the direction of the frames, and the middle one upright, forming the lateral shoots, which it throws out horizontally on each side; and, if they are not thrown off sufficiently low, heading the upright one down, by which lateral branches will be sent off, so as to range with regularity at the distance of six or seven inches, one above another, on each side, from the bottom to the top. In this way the trees have a very neat appearance.

In planting the trees out, when they are of the apple or pear kind, on dwarf stocks, the distance in the rows should be fifteen, eighteen, or twenty feet; and when on free stocks, not less than twenty or thirty; and for free growing trees considerably more. For plums, the distance should be eighteen feet or more; and for cherries, apricots, almonds, and mulberries, it should never be less than fifteen. Considerably less distance will, however, be sufficient for filberts, especially in the poorer sorts of soil.

When these trees have been planted, it is the usual practice to put sticks down in a line to train them to for the two or three first years; but it has a much neater appearance to have the treillage fixed down to train them to at once.

Frames for this use are made in different ways, according to the taste of the person who has them; but the most usual sorts are those constructed of three or four inch square pieces of oak timber for the posts, with rails of deal carried from post to post, at the distance of every ten or twelve inches from the bottom to the top. Between these rails thin upright pieces are again sometimes fixed at the same distances, for particular purposes. The whole should be well painted over in oil some time before the trees are to be trained to it. This last is performed either by tying the branches to the trellis by osier twigs, woollen-yarn, or other similar substances, or by nailing them in the manner of wall-trees. In whichever way it is done, the greatest exactness and regularity should be observed in laying in and directing the shoots, that they may have a neat regular appearance. The manner of performing the future pruning and managing of these trees will be explained when we come to speak of the nature of pruning in general. See PRUNING of Fruit Trees.

These sorts of trees are chiefly advantageous in admitting the branches to produce fruit spurs on both sides, which is not the case with wall-trees; in taking up but little room in the garden; in not being so injurious to the crops that are near them; in affording fruit of a finer flavour, from the more free admission of air and sun, and in the fruit not being so liable to be blown down and injured as in other cases.

ESPALION, in *Geography*, a small town of France, in the department of the Aveyron, chief place of a district of the same name, with a population of 2622 inhabitants. It is situated on the river Lot, 18 miles N.E. of Rhodéz, and has some manufactures of coarse woollen cloth. The canton has a territorial extent of 167½ kilometres, 12 communes, and a population of 9139 individuals.

As chief place of a district, Espalion has a sub-prefect, a court of justice, and a register office. Corn, wine, and madders, grow in its neighbourhood, and the whole district contains 9 cantons, 101 communes, and 58,855 inhabitants, on a territorial extent of 1630 kilometres.

ESPAMISCACK, a lake of Lower Canada; 74 leagues N.E. of Quebec. N. lat 50°. W. long. 68°.

ESPAQUE, a town of Persia, in the province of Segeftan; 54 miles S.W. of Kin.

ESPARCET, in *Agriculture*, a name sometimes given to faintfoin. See SAINTFOIN.

ESPARRAGOSA, in *Geography*, a town of Spain, in the province of Estremadura; 35 miles E.S.E. of Merida.

ESPARRAGUERA, a town of Spain, in the province of Catalonia; 15 miles N.N.W. of Barcelona.

ESPARZA, a town of Spain, in Navarre; 22 miles E. of Pamplona.—Also, a town of North America, in Mexico, and province of Costa-Rica.

ESPEJA, a town of Spain, in the province of Cordova; 17 miles N.N.E. of Montilla.

ESPELETTE, a small town of France, in the department of the Lower Pyrenées, chief place of a canton in the district of Bayonne, with a population of 1200 individuals. Its canton has a territorial extent of 237½ kilometres, 7 communes, and 7861 inhabitants.

ESPEN, ZEGER BERNARD VAN, in *Biography*, was born at Louvain in the year 1646. After going through the usual course of studies at the university, with much credit to his talents and diligence, he was admitted to priest's orders in the year 1678, and had, within two years of this time, the degree of doctor of laws conferred upon him. From this period till the year 1702, he lived in the college of pope Adrian VI., where he performed the duties of professor, and applied himself to the study of those works which have rendered his name illustrious. He obtained so much respect by his various writings that he was consulted from every quarter: by the tribunals of justice, by the bishops, and by several sovereign princes. His principal work was entitled "Jus Ecclesiasticum Universum." Besides this, he is well known for other treatises, "De peculiaritate et Simonia;" "De Officiis Canonicorum;" "Tractatus Historico-Canonicus in Canones;" "De promulgatione Legum Ecclesiasticarum," and many others, all of which were collected and published in 4 vols. folio, in 1753, at Paris. When he was in his 65th year, he was deprived of sight by a cataract, which was not removed for two years; during this time, however, he neither lost his cheerfulness, nor remitted his application. His manner of living was at all times frugal, and very simple, his temper was benevolent, modest, and humble. He was eminent for piety towards God, and for his candour and good-will towards men. He nevertheless had made himself enemies, by the integrity and independence of his mind; some of whom, to render Espen obnoxious to the ruling powers, had forged a treatise, containing some things very offensive, in a religious and political point of view, which they attributed to him; but he luckily detected the imposture, and punished the agents. On other accounts, he met with severe and unmerited persecution, and in one instance, after a variety of processes, sentence was pronounced against him, without any declaration respecting the definitive judgment of the court. Under these circumstances, believing that it was intended to put him under an arrest, he withdrew to Maestricht, and afterwards to Amersfort, in the province of Utrecht, where he died in 1728, in the 83d year of his age. He left behind him, which was afterwards published, a learned treatise, entitled "Commentarius in Canones Juris Veteris ac Novi," and other dissertations, which are said to contain discussions on some of the most important points in moral philosophy, as well as the canon and civil laws. Moreri.

ESPENCE, CLAUDE DE, was born at Chalons sur Marne in the year 1511. He received his education at

different colleges in Paris, to the principal of which he was chosen rector at a very early age. When he was about thirty years old, he took his doctor's degree, soon after which he was invited by the cardinal of Lorraine to reside in his house, to manage the ecclesiastical concerns of which he had the care. In the year 1544 he accompanied the cardinal on an embassy to Flanders, to negotiate a treaty of peace between Francis I. and the emperor Charles V. He was afterwards selected by the king to assist at the ecclesiastical conference, to consider the questions proper to be proposed for discussion at the council of Trent; and in 1547 he was deputed by Henry II. to attend the council of Trent, which was then transferred to Bologne. Some years afterwards he was employed in negotiating at Rome in favour of the French court, where his talents, as a diplomatic minister, produced such an impression in his favour, that the pope, Paul IV. wished to attach him to his interests by making him cardinal. He declined the intended honour, and having finished the business on which he was sent to Rome, he returned to his native country, where he appeared with high reputation at a meeting of the States at Orleans in the year 1560. In the following year he was appointed a member of the conference at Poissy, where he attached himself to the Calvinists, which was highly disagreeable to the Catholic divines, by whom he was likewise suspected of being the author of a treatise on Image Worship, which occasioned him some trouble with the faculty. After this, he passed his life in retirement, devoted to his studies, till he died at Paris in the year 1571. His works are chiefly theological; the most important are his "Commentaries on the Epistles of St. Paul to Timothy and Titus;" in these, several questions relative to hierarchy and ecclesiastical discipline are discussed. Most of his treatises were written in the Latin language, in the knowledge of which he was supposed to excel his contemporaries. He was one of the most learned, judicious, and moderate ecclesiastics of his time. He was very conversant in the canons and discipline of the church; and not less celebrated for his knowledge of profane literature. He was attached to the Catholic religion, but was a decided enemy to every species of persecution and intolerance. Moreri.

ESPER, JOHN FREDERIC, was born at Drossenfeld, in Bayreuth, in 1732. He studied very diligently at Erlangen, where he applied himself chiefly to theological pursuits, but at the same time made himself well acquainted with natural history and botany, of which he afterwards became a teacher. He died of a fever in July 1781, leaving behind him a considerable reputation as a naturalist, particularly in that department which relates to the zoolites in the principality of Bayreuth. In this place are a number of large subterranean caverns, partly insulated, and partly connected with each other, which contain immense numbers of bones of various animals, thrown together in heaps to a considerable height, and covered with the earth arising from decomposed animal bodies. The entrance to these caverns is highly picturesque, but almost as soon as a person enters them he is surrounded by darkness, and the passage becomes still more difficult and narrow, till the eye at last is struck by the immense extent of an awful arch, which on every side presents fissures and clefts, strewed with the fragments of once living bodies, which excite the idea of a repository of the dead. With the aid of an ingenious apothecary of Erlangen, Esper undertook an examination and description of these curiosities, and published the result of his labours under the following title; "An accurate Description of the Zoolites of Unknown Animals, &c." This was published at Nuremberg, in the year 1774, in folio, with

fourteen illuminated plates. Esper was author likewise of various papers in the Transactions of the Friendly Society of the Searchers into Nature: and he wrote an account of "A Method of determining the Orbits of Comets, and other Celestial Bodies without Instruments, or Mathematical Calculations." Gen. Biog.

ESPERAZA, in *Geography*, a town of France, in the department of the Aude, and district of Quillan;  $2\frac{1}{2}$  leagues S. of Limoux.

ESPERNAY. See *EPERNAY*.

ESPERNON, a small town of France, in the department of Eure and Loire, on the river Guesle; 15 miles N.E. of Chartres, and 6 miles E. of Maintenon.

ESPESEL, a town of France, in the department of the Aude, and district of Quillan;  $2\frac{1}{2}$  leagues S.W. of Quillan.

ESPHLASIS, (from *εσφρασις*, to recede inwards,) in *Surgery*, a recession of a part of the body inwards, in consequence of some violent outward force.

ESPIERRE, a town of Savoy, in the county of Maurienne, on the river Arc;  $3\frac{1}{2}$  miles S. of Argentina.

ESPIERS, in *Geography*, a town of Flanders; 5 miles N. of Tournay.

ESPINAL. See *EPINAL*.

ESPINAR, a town of Spain, in Old Castile; 18 miles S.S.W. of Segovia.

ESPINHAL, a town of Portugal, in the province of Beira; 18 miles S.E. of Coimbra.

ESPINOSA DE LOS MONTEROS, a small town of Spain, in Old Castile; situated in a pleasant valley, watered by the river Trueya, among the mountains of Burgos, about 15 leagues N.W. of Miranda, in the north corner of the province.

ESPINOSA, a town of Spain, in New Castile; 44 miles S.W. of Toledo.

ESPIRITU SANTO, the largest and most westerly of the New Hebrides islands, in the South Pacific ocean, about 57 miles in length, and 30 in breadth.—Also, a province of Brasil, which is chiefly productive of sugar.—Also, a town of Brasil, seated in a fertile country on the sea-coast, with a small castle and harbour. S. lat.  $20^{\circ} 10'$ . W. long.  $41^{\circ}$ .—Also, a river of Brasil, which runs into the Atlantic.—Also, a town on the south coast of the island of Cuba; 55 miles S.W. of Bayamo.—Also, a bay on the west coast of East Florida. N. lat.  $27^{\circ} 36'$ . W. long.  $82^{\circ} 54'$ . It has a good harbour and safe anchorage; but the land about the sea-coast is very low. Several low, sandy islands and marshes, covered with Mangrove bushes, lie before the main land. This bay abounds in the summer with fish, which may be taken with a seine, in quantity sufficient to load a ship, if the climate would admit of curing them, in a few days.—Also, a lake towards the extremity of the peninsula of East Florida, south from the chain of lakes which communicate with St. John's river.

ESPIRITU Santo, *Ilas del*, islands situated on the S. W. of Providence in the West Indies. See *ANDROS islands*.

ESPLANADE, in *Fortification*, called also the glacis; a part which serves the counterscarp, or covert way, for a parapet; being a declivity, or slope of earth, commencing from the top of the counterscarp, and losing itself, insensibly, in the level of the campagne.

ESPLANADE also signifies the ground which has been levelled from the glacis of the counterscarp to the first houses; or the vacant space between the works and the houses of the town.

The term is also applied, in the general, to any piece of

ground which is rendered flat, or level; and which before had some eminence that incommoded the place.

ESPLEES, *EXPLETIE*, from *expleo*, in *Law*, the products which ground or land, &c. yield; as the hay of the meadows, the herbage of the pasture, corn of the arable, rents, services, &c. and of an advowson, the taking of tithes in gross by the parson; of wood, the felling of wood; of an orchard, the fruit growing there; of a mill, the taking of toll, &c. These and such like issues are termed esplees. And it is observed, that in a writ of right of land, advowson, &c. the demandant ought to allege in his count, that he or his ancestors took the esplees of the thing in demand; otherwise the pleading will not be good.

Sometimes this word hath been applied to the farm, or land, &c. themselves. "Donnaus E. habebit omnia expletias & proficua de corona emergentia." Plac. Parl. 30 Ed. I.

ESPOSENDA, in *Geography*, a town of Spain, in the province of Galicia; 12 miles S.W. of Orense.

ESPOSENDE, a small port town of Portugal, in the province of Entre Mimbo, at the mouth of the Cavado, three leagues S. of Viana. Its shallow harbour is slightly protected by a fort, 22 miles N. of Oporto.

ESPRIT, JAMES, in *Biography*, was born at Besiers in the year 1611. Having passed through his initiatory studies, to which he had applied himself with great diligence, he was introduced to the duke de la Rochefoucault, who brought him acquainted with the chancellor Seguier, who not only allowed him a pension from his own private purse, but procured for him a pension of two thousand livres, on an abbey and a brevet of counsellor of state. Through some secret enemies he incurred the displeasure of the chancellor, and withdrew to the seminary of St. Magloire, where he became acquainted with the prince of Conti, and at that time had serious thoughts of entering the church. This prince was so charmed with the conversation of M. Esprit, that he gave him handsome apartments in his own hotel, and a pension of a thousand crowns. In a short time afterwards Esprit gave up all thoughts of the ecclesiastical life, and determined to marry. On this occasion he received some handsome presents from the prince, to whom he became so much attached that he followed him, in 1766, to his government of Languedoc, and became his most confidential friend and adviser. After the death of his patron, he devoted the whole of his time to the education of that prince's children. He himself died at the place where he was born in 1678. As a literary man he left behind him "Paraphrases on some of the *Palms*;" and a treatise, entitled "La Fausseté des Vertus humaines," in two volumes, which was published the same year in which he died, and which was intended as a commentary on the maxims of his first patron the duke de la Rochefoucault, to show the fallacy of the virtues that are merely human, and the reality of Christian virtues. By the abbé Olivier and others he is supposed to have been the translator of Pliny's panegyric on Trajan. Esprit was a member of the French academy, and in its infancy was considered as one of its shining ornaments. Moreri.

ESPRIT, *Saint*, in *Geography*, a small town of France, in the department of the Landes, chief place of a canton in the district of Dax, with only 589 inhabitants. Its canton has a population of 10,161 individuals, dispersed in eight communes, on a territorial extent of  $147\frac{1}{2}$  kilometres.

ESPOUSALS, *SPONSALIA*, in *Law*, a contract or mutual promise between a man and a woman to marry each other. Marriage or matrimony is said to be an espousal or presenti.

ESPRONCEDA, in *Geography*, a town of Spain, in Navarre; 11 miles W.S.W. of Estella.

ESQUADRILLE. See QUADRILLE.

ESQUADRON. See SQUADRON.

ESQUERDES, in *Geography*, a town of France, in the department of the straits of Calais, and district of St. Omer; one league S. of St. Omer.

ESQUIAVINE, in the *Manege*, an old French word signifying a long and severe chastisement of a horse in training him.

ESQUILLÆ, or ESQUILINUS MONS; in *Ancient Geography*, one of the seven mountains on which Rome was seated, where was anciently one of the gates of the city, now the gate of St. Laurence, to whose magnificent church it leads. This gate seems to have been anciently called "Libitincensis," on account of the dead bodies that were carried through it, in order to their being interred in the "Campus Esquilinus," which was the general burying-place of the common people. The name of Esquilinus was varied, for facility of pronunciation, from Exquilinus, a corruption of Excubinus, *ab Excubiis*, from the watch that Romulus kept in this place. It was taken in by Servius Tullius, who had his royal seat upon this hill. Varro will have the Esquilæ to be two hills. To the east, it has the city walls; to the south, the via Labicana; to the west, the valley lying between Mons Cælius and Mons Palatinus; to the north, Mons Viminalis; and is in compass between three and four miles. It is now called "Il Montè de Santa Maria Maggiore." One of the 14 regions or wards, instituted by Augustus, was denominated "Esquilina." It contained 15 streets, eight luci, six temples, five ædes, 75 public baths, 18 granaries, 22 mills, and 180 great houses; and its circuit was 15,950 feet.

ESQUIMAUX, the inhabitants of the coasts of Labrador and Hudson's bay, who differ, in several characteristic marks, from the inland inhabitants of North America. That the Greenlanders and the Esquimaux agree in every circumstance of customs, and manners, and language, which are demonstrations of an original identity of nation, was discovered near half a century ago. Crantz, in his "History of Greenland," (vol. i. p. 262.) informs us, that the Moravian brethren, who, with the consent and furtherance of sir Hugh Palliser, then governor of Newfoundland, visited the Esquimaux, or the Labrador coast, found that their language, and that of the Greenlanders, do not differ so much as that of the high and low Dutch. Mr. Hearne, in 1772, traced this unhappy race farther back, towards that part of the globe, from whence they had originally exalted along in their skin-boats, having met with some of them at the mouth of the Copper-mine river, in the latitude of 72°, and near 500 leagues farther west than Pickersgill's most westerly station in Davis's strait. Their being the same tribe, who now actually inhabit the islands and coasts on the west side of North America, opposite to Kamtschatka, is a discovery, the completion of which was reserved for captain Cook. The reader of his third voyage will find them at Norton sound, and at Oonaleska, and Prince William's sound; that is, near 1500 leagues distant from their stations in Greenland, and on the Labrador coast. And lest similitude of manners should be thought to deceive us, a table exhibiting proofs of affinity of language, drawn up by captain Cook and inserted in the appendix to the work just cited, will remove every doubt from the mind of the most scrupulous inquirer after truth. See *NEW BRITAIN* and *LABRADOR*.

ESQUIMAUX Bay. See *ESKIMAUX*.

ESQUINANCY, in *Medicine*, from the French *esqui-*

*nancie*; whence our more common term *quinsy*. See *CYNANCHE*.

ESQUIRE, a title of distinction, next below that of knight, and above that of a simple gentleman.

The origin, both of the name, and the thing, esquire, is very obscure. The English denomination is confessedly borrowed from the French, *escuyer*; and that from the Latin *scutum*, shield, as some will have it; or, as others, from *scutarius*, or *scutiger*, shield-bearer; or from *scuria*, stable; or from *equiso*, groom. So many different opinions of the formation of the word have given rise to as many about the primitive office of esquires; unless, perhaps, the latter hath given occasion to the former. Pasquier, in his *Recherches*, liv. ii. chap. 15. maintains the title of esquire, *escuyer*, *scutarius*, to be very ancient. From the time of the declension of the Roman empire, he observes, there were two extraordinary kinds of soldiery in the Roman army: the one called *gentiles*, and the other *scutarii*.

Ammian. Marcellin. lib. xiv. cap. 7. and lib. xvi. cap. 4. speaks of these *scutarii* as men of redoubted prowess, and even deemed invincible: it is added, that Julian the Apostate set a mighty value on those troops, when he was among the Gauls; and hence, probably, it was, that the Gauls, or perhaps only the Franks, finding the bravest among the Roman forces were called *gentiles*, and *scutarii*, gave the like names to the boldest and bravest among themselves; such, according to that curious antiquary, is the original of esquires.

Esquire, however, afterwards came to be used in a somewhat different sense; *viz.* for a gentleman who attended a knight in the wars, and on other military occasions; bearing his shield, *scutum*, before him (whence he was called *scutarius*, *scutiger*, or *scutifer*), as also his lance, and other weapons; whence his other Latin appellation, usual among us, *armiger*, *q. d. armour-bearer*. And hence likewise it is, that, in all our ancient romances, the hero is constantly attended by a gentle and truly *Esquire*.

After all, the most probable derivation of *escuyer* is not from *escu*, *scutum*, as is the common opinion; but from *equus*, horse; the primitive esquires being no other than what the Latins call *equisons*, who had the care and intendance of the equerries, or stables, only.

Be this as it will, the title *esquire*, *armiger*, as now established among us, is next below that of knight, *equus*. They who bear this title are all younger sons of noblemen, and the eldest sons of such younger sons; the eldest sons of knights, and their eldest sons successively; both which species of esquires sir Henry Spelman entitles *armigeri natalitii*; the four esquires of the king's body, now difused, and esquires created by the king, by putting about their necks a collar of SS's, and bestowing on them a pair of silver spurs, letters patent, or other investiture, and their eldest sons. Lastly, divers others, in the superior public offices, are reputed esquires, or equal to esquires; as sheriffs of counties, serjeants at law, justices of peace, mayors of towns, counsellors at law, lieutenant-colonels, majors, captains, &c. during the time of their commission. Lastly, the heads of some ancient families are likewise esquires by prescription. To these may be added the esquires of knights of the Bath, each of whom constitutes three at his installation; and all foreign, nay Irish peers; for not only these, but the eldest sons of peers of Great Britain, though frequently titular lords, are only esquires by the law, and must be so named in all legal proceedings. See *GENTLEMAN*.

ESQUISSE, in the French *Painting*, a term signifying the first slight sketch or draught of a picture; the first thought

thought of a design drawn hastily with a crayon; or in colours, on paper, canvas, or the like, in order to be finished, and painted, or engraven afterwards.

He had not the trouble of making a finished and correct design, but went to work upon the esquisse.

The word is formed of the Italian *schizzo*, a splash; because an esquisse of a painting only represents, as it were, splashes, or dabs, of colours.

ESQUIVO. See ESSEQUIVO.

ESRAKITES. See ESCHRAKITES.

ESS, in *Agriculture*, a term made use of in some places to signify ashes.

ESSA, in *Ancient Geography*, a town of Palestine, on the other side of Jordan, according to Josephus, who says that it was taken by Alexander, king of the Jews.

ESSACHORDO. See HEXACHORD.

ESSÆANS. See ESSENI.

ESSAORE, in *Geography*, a town of Egypt; three miles S.S.E. of Achmin.

ESSARS, LES, a town of France, in the department of La Vendée, and district of La Roche-sur-Yon; 3 leagues N.E. of La Roche.

ESSART, of ASSART. See ASSART.

Du-Cange derives the word from some of the barbarous Latin words, *exartus*, *exartum*, *essartum*, *assartum*, *fartum*, and *fartus*; which all signify a forest cut down, or dug up; though Spelman chooses to deduce it from the Latin *exertum*, torn up, or unrooted. Others from *farrine*, to weed; and others, lastly, from *exaro*, I plow; whence *exarare*; and, by contraction, *exartum*. In our ancient law-books, "exartum facere in sylva," is to essart a place in a forest. To essart, is to grub up, or extirpate bushes, trees, old roots, stumps, or the like; in order to fit the ground for tillage.

ESSARTS, LES, in *Geography*, a small town of France, in the department of La Vendée, chief place of a canton in the district of Montaigne, with a population of 2089 individuals, 24 miles W. of Mauléon. Its canton contains 9 communes, and 9043 inhabitants, on a territorial extent of 242½ kilometres.

ESSATUM, a word used by some of the chemical writers to express the medicinal power or sanative property residing in simple medicines.

ESSAY, a trial, or experiment, to prove whether a thing be of the requisite quality or goodness.

The word is French, *essai*; which some authors derive farther from the Latin *examen*.

ESSAY is also used for an attempt, or tentative, to learn whether or not a thing will succeed.

Essays of machines should be made in large; it is not enough that they succeed in little.

ESSAY, in *Monasteries*, is particularly used for a trial which a person makes of the monastic life, in a secular habit.

This essay is of one, two, and, in some monasteries, of three months. The essay is not reckoned in the noviciate. See PROBATION.

ESSAY, or *Assay*, or simply *Say*, in *Coinage*. See ASSAY.

ESSAY, in matters of learning, is a peculiar kind of composition; whose character is to be free, easy, and natural; not tied to strict order, or method, nor worked up, and finished like a formal system.

The matter of an essay is supposed to consist principally of sudden and occasional reflections, which are to be wrote much at the rate, and in the manner, a man thinks; some-

times leaving the subject, and then returning again, as the thoughts happen to arise in the mind.

At least, this has hitherto been the practice; and Montaigne, who has acquired no small reputation by this way of writing, seldom keeps many lines to the subject he proposes; though it is our opinion, that lord Bacon, in many of his works, is a better pattern in the essay kind. Mr. Locke, however, and a few other authors, use essay in a stricter sense: the Essay of Human Understanding, every body knows, is a regular, artful, and laboured work; though perhaps so called to guard against too severe strictures, by pleading the title.

ESSAY-hatch, is the miners term for a little trench or hole, which they dig to search for shoad; or ore. See TIN.

ESSAY-master. See MINT, and ASSAY.

ESSE, in the *School Philosophy*, is used in the same sense with essence; principally for that which is actual, or actually existing.

The word is pure Latin; being the infinitive of the verb *sum*, I am; whence *esse*, to be.

From esse arises *essatum*, a barbarous term, now almost obsolete, signifying that which is ended with essence, or nature; or affected with the virtue, or efficacy, of another. Some distinguish esse into *real* and *intentional*; and, again, into *essatum* and *volitum*.

ESSEDARIUS, among the Romans, a gladiator, who fought in a car or chariot. See Hist. Acad. Inscrip. vol. ii. p. 376. seq.

ESSEL, or EBSTEL, in *Geography*, a town of Germany, in the circle of Westphalia, and county of Verden; 2 miles N. of Verden.

ESSEN, a small town of Germany, in the circle of Westphalia, remarkable for its manufactures, chiefly of swords and fire arms; but more particularly for a rich abbey, which, until the peace of Luneville in 1801, was a free imperial abbey. It was secularized, and its possessions, together with the town and its territory, were given to Prussia as an indemnity for her losses on the right shore of the Rhine. After the peace of Tilsit in 1807, when Prussia lost all her dominions beyond the Elbe, Essen was added to the grand duchy of Berg and Cleves, which now belongs to the eldest son of the king of Holland. There are other towns of this name in the circle of Westphalia.

ESSENBACK, a town of Denmark, in Jutland; 4 miles from Randers.

ESSENBERG, a town of Germany, in the circle of Westphalia, and county of Meurs, near the Rhine; 3 miles E. of Meurs.

ESSENCE, a term much used among the schoolmen; and denoting what the Platonists called the idea of a species. The word *essentia* is said to have been made by Cicero; but his authority could not give it currency, until long after his time. It came at last to be used, and the schoolmen fell into much the same opinions concerning essences, as the Platonists held concerning ideas. The essences of things were held by many to be uncreated, eternal, and immutable. Mr. Locke distinguishes two kinds of essence, the real and the nominal. By the former he means the constitution of an individual, which makes it to be what it is. This essence must begin and end with the individual to which it belongs. It is not therefore a Platonic idea. But the latter or nominal essence, so called by Mr. Locke, is the constitution of a species, or that which makes an individual to be of such a species; and this is nothing but that combination of attributes which is signified by the name of the species, and which we conceive without regard to existence. The essence of a species is, therefore, what

what the Platonists called the idea of the species. The nominal essence depends on the real essence; thus, the nominal essence of gold, is that complex idea which the word gold represents; *e. gr.* a body, yellow, heavy, malleable, fusible, and fixed; but its real essence is the constitution of its insensible parts, on which those qualities, and all its other properties depend; which is wholly unknown to us.

In philosophy, the essence of a thing is defined to be, that whereby a thing is distinguished from every other thing. The Cartesians hold the essence of matter to consist in extension; and, on that principle, deny that there is any such thing as mere space, or vacuity; but the hypothesis is false, as will be shewn under the articles MATTER, SPACE, VACUITY, PLENUM, &c.

Gassendus, and most of the corpuscular philosophers, hold the essence of matter to consist in solidity, or impenetrability, resistance, or, more adequately, in a solid impenetrability resisting the touch; which it must be allowed, of all the properties of matter, seems to have the fairest title to it.

The school philosophers give us two significations of the word essence; the first denotes the whole essential perfection of a being, and, consequently, its entity, with all its intrinsic, or essential, and necessary attributes, taken together; in which sense, essence may be defined to be, all that whereby a thing is, and what it is. In which case the essence of a thing is to the thing itself, what humanity, *e. gr.* is to man.

The second signification of essence is; that whereby it denotes the principal, and most intimate, of all the attributes of a thing; or that which agrees to every such thing, and such alone, and that always, and in such manner, as that the mind, with all its attention, cannot perceive any thing prior thereto; by which, essence is distinguished from the essential attributes, *i. e.* from such as flow from its essence, or first attribute. Thus, the essence of the human mind is commonly supposed to consist in the power of thinking; because all its other perfections seem to pre-suppose this; but this pre-supposes none. And thus the powers of understanding, doubting, assenting, willing, &c. do all flow from the power of thinking; and cannot exist without it, though this may without any of them.

It must be allowed, however, that the essential properties of a thing do so closely cohere, nay, and inhere, in the essence itself, that it is scarcely possible to distinguish the one from the other. Hence, what some urge, that, setting aside all the attributes and properties of a thing, and what remains is its essence, is a mere chimera. For set aside, *e. gr.* from the mind, the powers of understanding and willing, with the rest of its attributes, and what will there remain to call its essence?

It is greatly disputed, in the schools, whether the essences of created things be eternal? or whether the essences, as well as their existence, had their origin in time? The Cartesians hold, that the essences of things depend absolutely on the free concurring will of God.

ESSENCE, *Essential oil*, *Essential salt*. The essence of a vegetable, according to the old chemists, was, that one of its proximate elements, in which resided the quality of taste or odour, which peculiarly distinguished it from other vegetables, and rendered it especially applicable to pharmaceutical purposes. Thus the fragrance of orange peel, of pepper-mint, of cinnamon, was found by experience to be separable from the other parts of the vegetable, by means of distillation, &c.; the result of this process was a small portion of highly fragrant oil, in which was contained the entire odour that had been naturally dispersed through the

whole mass: hence the oil thus procured obtained the name of "essential oil." Again, most four vegetables, as fennel, lemons, &c. owe this quality to the presence of an acid, which, when separated from the other vegetable principles, assumes a crystalline appearance, and was known by the name of their essential salt. The same appellation was also given to all those vegetable principles which, when pure, are capable of crystallizing, whether they were acid to the taste or not. Thus sugar was ranked among the essential salts. The term, however, is at present obsolete. Essential oil still retains its place in chemical nomenclature, and we refer the reader to the article OILS, *essential*, for a particular account of their species and properties.

ESSENCE of *Roses*. See ROSES.

ESSENCE, *Ward's*. See WARD'S *Medicines*.

ESSENCE of *Wine*, a term used by Paracelsus, and some of the German chemists since his time, to express what is called sometimes the philosophical spirit of wine, or the spirit of wine of the ancients. It is not a distilled spirit like what we call spirit of wine, but approaches more to what Stahl has greatly recommended to the world, under the name of concentrated wine, or wine whose strength has been reduced to a smaller compass, by separating its aqueous parts only by freezing. Stahl recommends the immediately exposing of wine to the frosty air on this occasion; but the process ordered by Paracelsus for the preparation of this liquor is more tedious. He orders that the finest and best flavoured wine be chosen; that it be put into a glass, filling it up three parts in four: and the neck being then sealed hermetically, it is to be put into horse-dung for three months, and then exposed to the frosty air for a month, after which the ice is to be thrown away, and the liquid part, which is the essence, preserved. Shaw's *Chemical Essays*.

ESSENDO *Quietum de Tollonio*, in *Larw*, a writ to be quit of toll, and lies for citizens and burghesses of any city or town that by charter or prescription ought to be exempted from toll, where the same is exempted of them. Reg. Orig. 258.

ESSENEUX, in *Geography*, a town of the Netherlands, in the duchy of Limburg, situated on the Ourt; 9 miles S. E. of Liege.

ESSENI, ESSENES, or *Essians*, an ancient sect among the Jews.

As to the etymology of the name, critics have been much divided. Philo derives it from *עצום*, *holy*; Epiphanius from *ישבי*, *Jisbai*, *Jesse*, the father of David; Salmasius from a city called *Essa*, mentioned by Josephus; whence he apprehends the sect first sprung; Godwin derives it from the Syriac word *נסן*, *asa*, which signifies *to heal*; because Philo calls one branch of the Essenes *Therapeutæ*; and Serrarius enumerates at least a dozen different etymologies. Philo in *Traët. Omnis probus Liber. Oper. p. 678. Colon. Allobr. 1613. Epiphan. Hæres. xix. lib. i. Salmas. Plin. exercit. in Solin. cap. 35. Serrar. Trihæres. Jud. lib. iii. cap. 1. p. 106. 110. edit. Trigland. 1703. The principal ancient writers, who give any considerable account of the Essenes, are Josephus, Philo, and Pliny. Jos. de Bell. Jud. lib. ii. cap. i. cap. 8. & 12. and *Antiq. lib. cxiii. cap. 9. 13. 19. lib. xviii. cap. 1. & cap. 2. & alibi. Philo. ubi supra, & De Vita contemplativa, p. 688. ed. col. Allobr.**

As to the origin of this sect, Pliny asserts, without mentioning his authority, that it had subsisted for several thousand years. The most probable opinion is, that this sect was formed by Jewish exiles, a little before the time of the Maccabees, who were forced to fly from the persecution of their enemies into caves and deserts. The first Essenes we read of are mentioned in the fourth book of Maccabees, under the

name of Hasdanim, and by Josephus; both which accounts agree that they were already settled in Judæa, in the time of Jonathan, the brother and successor of Judas Maccabæus, about a hundred and fifty years before Christ. Josephus states that their number in Judæa was about four thousand, meaning, as Dr. Lardner (Works, v. i. p. 128.) suggests, those of them, that entirely rejected marriage. Philo says, that in Syria and Palestine there were about 4000 of them, but he makes the number in Egypt much greater. Philo says, that they sacrificed no living creatures, and that they shunned cities. Josephus says that they sent presents to the temple, but offered no sacrifice there. They seem therefore not to have exposed themselves much to public view, nor would they admit a man of another sect into the apartments in which they lived. Some have expressed their surprise, that no mention should be made of this sect in the New Testament. This proceeded, as some imagine, from their retired mode of living, by reason of which they never came under our Saviour's observation, as the Pharisees and Sadducees often did. Others suppose, that, being very honest and sincere, without guile or hypocrisy, they gave no reason for that reproof and censure, which the others very justly merited. It should be considered that it was the design of the evangelists to write the history of our Saviour's ministry, and not that of the Jewish sects. Prideaux observes, that almost all that is peculiar in this sect is condemned by Christ and his apostles. Prid. Conn. vol. iii. p. 384. However, it has been supposed, that they are referred to, by the apostle Paul in his epistle to the Colossians, ch. ii. 18. 21. 23.

Josephus, making mention of the several sects among his countrymen, distinguishes three; *viz.* the Pharisees, Sadducees, and Esseni; which last he prefers to the two former, as to their manner of life. He assures us, farther, that they were Jews, by original; from which it should appear, that St. Epiphanius was mistaken in ranking them among the Samaritans.

In effect, the Esseni appear to have been true Pythagorean philosophers, in every thing that related to their manner of living; for they greatly affected solitude and retirement; and avoided all conversation with women, to devote themselves more entirely to the contemplative life. Grotius will have the Esseni the same with the ancient  $\text{ἡσσηνοὶ}$ , *Hasidim*, or *Hasidai*; thus called, according to Philo, from their singular piety, humility, and devotion. Among these, Gale observes, it was, that the Hebrew philosophers chiefly flourished. Porphyry is very prolix in his praises of the Esseni:  $\text{Ἔστι τῶν αἰνῶν ἐσσηνοὶ ἰσχυροὶ μὴ τὸ γενεὸς φιλαλλέων, \&c.}$  He represents them as despisers of pleasures, riches, glory, and delicacy; and strenuous retainers to continency, austerity, study, &c. He adds, they decline marriages, and adopt and educate other people's children in the principles of religion and philosophy; they are all on a level, hold every thing in common, neither buy nor sell, &c. By long habit, they arrived at such a degree of patience, that Porphyry assures us, flames and tortures had not the least effect on them. They scorned to treat their tormentors; nor ever shed a tear; but would smile under all their agonies, &c. As to their learning, Philo Judæus, in his treatise, That every good Man is free, tells us, that they despised logic, as useless to the acquiring of virtue; physics they left to the sophists and disputants, as judging it to transcend the human faculties; and applied themselves wholly to morality. Porph. de Abst. lib. iv. § 11. seq. Gale Philos. Gener. lib. i. cap. 1. § 11.

Both Josephus and Philo give a surprising account of their austere way of life, which the curious reader may see at

large in Prideaux's Conn. ubi supra. Their houses were mean; their cloaths made of wool, without any dye; they never changed their cloaths or shoes till they were quite worn out; their food was plain and coarse, and their drink water; they neglected all bodily ornaments, and would by no means anoint themselves with oil, according to the fashion of those times. They lived in sodalities, and had all their goods in common; their morals were very exact and pure, and they kept the Sabbath more strictly than any of the Jews. Before any of them were admitted to the common table, they bound themselves by a solemn oath to observe the rules of the society, which were very strict and exemplary.

Some have said that the Essenes, as well as the Pythagoreans, prohibited oaths; that they used only inanimate sacrifices, and that they not only worshipped towards the rising sun, but worshipped the sun itself. But it has been urged, that neither of these charges seem to be well founded; or at least, that it is difficult to reconcile them with their known veneration for the writings of Moses, and other instances of their conduct. Pliny, and others on his authority, have asserted, that they wholly declined marriage; and Pliny (lib. v. cap. 17.) with more wit than justice, says, that for several thousand years, this people is perpetually propagated without any being born among them, so fruitful and prolific unto them is the repentance of others. But Josephus informs us (De Bell. Jud. lib. ii. cap. 1.) that there is one sort of Essenes, who agreed with the others, except in the article of marriage. For they reckoned, that those that do not marry cut off a great part from the number of the living, and that thus the whole race of mankind would soon be extinguished. Accordingly they made choice of those women, who, after three years trial, were found fit to bear children, and never cohabited with them after they were known to be with child; consulting the propagation of their species, and not their own gratification in this business.

With respect to the religious opinions of the Essenes, they believed the existence of angels, the immortality of the soul, and a future state of rewards and punishments, but denied the resurrection of the body. They maintained, that fate governs all things, and that nothing happens to man but by its appointment.

The Esseni seem to have been, among the Jews, what the most retired and austere monks are, or were, among the Christians: which was what gave them their denomination of  $\text{Ἰουδαϊκοὶ ἀσκητικοὶ}$ , *Jewish ascetics*.

Many Catholic writers have even deduced the origin of monks from them; building, principally, on what Philo relates of them, who divides them into two branches, or sects; the one who married, and the other who lived in celibacy.

Josephus seems likewise to have had an eye to these two sorts of Esseni: Serrarius, who has wrote very amply on the subject, follows Philo in making two classes of Esseni. The first are those whom he calls *Prædici*, and who lived in community; the second, those called *Theoretici*, who lived in solitude, and led a life of pure-contemplation. He adds, that Josephus only makes mention of the first; omitting the contemplative kind, whom Philo calls *Therapeutæ*, and who were principally found in Egypt. See *Therapeutæ*.

Eusebius holds, that the Esseni, called *Therapeutæ*, were real Christians, or Jews converted by St. Mark, who had embraced this kind of life. Scaliger, on the contrary, maintains, that these *Therapeutæ* were no Christians, but real Esseni, who made profession of Judaism; however, he

he allows of the two kinds of Esseni above-mentioned. But Valesius, in his notes on Eusebius, absolutely rejects any such distinction: he denies that the Therapeutæ were any real Esseni; and that chiefly on the authority of Philo himself, who never calls them Esseni, and who places the Esseni in Judæa and Palestine; whereas the Therapeutæ were spread throughout Greece, Egypt, and other countries.

Some traces of the Essenes are found under the emperor Trajan, and under Justinian; but they were much degenerated from their primitive purity both of doctrine and manners; and the sect about that time became extinct. Though the Therapeutæ, as well as the Essenes, were strictly Jews, and not Christians, it is not impossible, that some of them, becoming Christians, might still affect their former reclusive way of living; and being imitated by others, laid the foundation of monkery among Christians.

ESSENIAS, ANDREW, in *Biography*; a learned Dutch divine, was born at Bommel in the year 1618. He was educated chiefly at Utrecht, was admitted to the exercise of the ministry in the year 1639, and in the following year took the degree of M. A. He obtained some preferment, and took his doctor's degree in the year 1645. Soon after this, he was chosen pastor of the principal church at Utrecht, and in 1653 was appointed professor of theology at that university. He died in 1677, leaving behind him many works, that were very highly esteemed by his contemporaries. He was what the world has usually denominated an orthodox divine, and wrote against Crellius, and others among the Unitarians. One of his largest publications was "A System of Divinity," in 2 vols. His most popular piece was entitled "A short View of Theological Controversies, with an Index to Scripture Passages." This has gone through many editions. Moreri.

ESSENTIA DULCIS, in *Chemistry*, a name given by Kunkel, and some others of the German authors, to a menstruum, of which they relate wonderful effects; but the preparation of which seems hitherto a secret. They say this menstruum has nothing acid or corrosive in it, but that it approaches to the nature of spirit of wine, yet that it is capable of dissolving the most dense metals, and of converting any of them into a pure white salt, which has all their virtues, but nothing of that vitriolic acrimony, which they have when prepared in the common way. The salts of mercury and of gold thus prepared have great praises bestowed on them, and are said to cure epilepsies, the venereal disease, and many other distempers, without any violence or danger. Kunkel, De Salis Metal. See METAL.

ESSENTIAL, something that is necessary to constitute a thing, or that has such a connection with the nature and reason of a thing, that it is found, or supposed, wherever the thing itself is.

Thus, it is essential to God to be just. Mr. Locke has laboured to overturn that great principle of the Cartesians, that thinking is essential to the soul.

The heart, brain, and spinal marrow, are parts ordinarily supposed essential to life, or without which life cannot be; yet we have instances, in history, of children being found, and alive, without almost any of those parts. See BRAIN, &c.

ESSENTIAL characters, in *Natural History*, or *Diagnosics*, are such particulars as mark or distinguish a plant or animal from all others in the same genus or order. Mr. William Martin, in his "Outlines of the Knowledge of Extraneous Fossils," p. 189, states the principles under five heads, which should direct the choice of parts of a fossil animal or

plant, to be considered as its diagnostic or essential characters. See RELIQUIA.

ESSENTIAL oils. See OILS.

ESSENTIAL properties, are such as necessarily depend on and are connected with, the nature and essence of any thing, so as to be inseparable from it; in distinction from accidental.

ESSENTIAL salts, are those prepared from decoctions, or those which are found crystallized in the juices and infusions of plants; in contradistinction to those made by incineration. See SALT.

ESSENTIAL Fever, Form, Mode, Part, Perfection. See the substantives.

ESSEQUEBO, or Esquivo, in *Geography*, one of the four provinces into which the Dutch possessions in Guiana are divided; the other three being Surinam, which is the chief settlement, Berbische or Berbiz, and Demerara. This settlement derives its name from that of the large river on which it is situated, and which at its discharge into the Atlantic is 3 leagues wide. The productions of this country are sugar, coffee, and cotton. See GUIANA, SURINAM, BERBISCHE, and DEMERARA.

ESSERA, a river of Spain, which runs into the Cinca, in Arragon.

ESSERA, ESSERE, or Sere, in *Medicine*, a generic denomination, used by the Arabian physicians, and comprising several popular eruptions, and rashes, which appear on the skin: especially the eruption of the summer season, in warm climates, which has been termed the PRICKLY-heat, the NETTLE-rash, the PRURIGO of Dr. Willan's classification; &c. See these articles. See also Willan on Cutaneous Diseases, genus Lichen.

ESSERUM, in *Geography*, a small town of Denmark, in the island of Zealand, in the district of Cronburg, and the herred of Holboe. Before the Reformation it was remarkable for a rich monastery of Bernardines, founded in 1150, in an extremely pleasant country, watered by lakes abounding in fish. But Esserum is now much more interesting for a royal stud of horses, and for having constantly flocks of the most renowned foreign sheep, Spanish and others, which are distributed among the farmers to improve the Danish breed. In the beginning of the year 1800, there were at Esserum 652 choice sheep, of which 223 ewes, and 33 rams, were Spanish of the best Merino breed. Cateau Tableau des Etats Danois, vol. ii. p. 147.

ESSE, in *Military Language*, are fixed to draught chains, made in the form of an S; one end of which is fastened to the chain, and the other to hook to the horse's harnesses, or to a staple; they serve likewise to lengthen and piece chains together.

ESSEX, in *Geography*, the name of one of the English counties, which has for its boundaries the German ocean and river Thames to the east and south; the counties of Suffolk and Cambridge to the north; and those of Middlesex and Hertfordshire to the west. The area of land thus encompassed measures about sixty miles in length from east to west, by fifty from north to south: its circumference being about 215 miles. It is divided into 20 parts, of which fourteen are hundreds, five half hundreds, and one a royal liberty. These are subdivided into about 400 parishes and townships, and twenty-five towns; containing, according to the late official report, 39,398 houses, and 226,437 inhabitants. When the Romans invaded Britain, this district, with that now denominated Middlesex, were inhabited by a class or tribe of the Britons, called Trinobantes, or Trinovantes, who possessed, according to Cæsar, and some other ancient writers,

ters, two considerable cities or fortified towns; one, the site of modern London; and the other, that of Colchester in this county. This tribe was the first to submit to and become vassals to the Romans, who, to keep them in subordination, established five military stations within this district. These were Duroplitum, Cæsaromagus; Canonium, Camalodunum, and Ad Ansam. These stations were all seated on the road which formed the fifth Iter from Londinium to Venta Icenorum, Caistor in Norfolk. Camalodunum was unquestionably the principal station in Essex, and though its site has been much contested by different writers, an attentive examination of the several places assigned, combined with a knowledge of the antiquities discovered in the vicinity of each, will admit little doubt of Colchester being the real situation. Essex formed a separate and distinct kingdom during a certain period of the Saxon Heptarchy, and was called East-Seaxa; but the times of its establishment and termination are not precisely authenticated. Turner states that this district, and East Anglia, were originally occupied by the Saxons at nearly the same period; and that Erkenwin was the first king of the former; commencing his reign in 527, and dying in 587.

By the Domesday-book it appears, that ninety land-owners of this county were deprived of their lands by the Conqueror, during whose reign the whole civil and ecclesiastical establishment of the kingdom, and of each county, underwent very considerable changes. Essex was now governed and tyrannized over by Norman barons, who constructed castles on their estates to secure themselves, and to awe their dependant vassals. In the civil wars between the houses of York and Lancaster, and in those of Charles's time, this county suffered greatly from the interference of the De Vere's in the former, and during the long siege of Colchester in the latter. Formerly there were twelve castles, or fortified buildings in this county; two of which, Landguard fort, and Tilbury fort, were denominated royal castles, as built for national security: the others were baronial residences, *viz.* Colchester, Hadleigh, Canfield, Hedingham, Clavering, Ralegh, Ongar, Pleshy, Stanstead-Montfichet, and Walden. These formidable fortresses, though once the pride of the nobility, and the terror of the peasantry, are mostly rased to the ground; the only parts remaining being their high keeps and wide fosses. At Colchester, Hadleigh, Hedingham, and Walden, some parts of the walls still remain. Essex composes part of that tract of country on the eastern side of England which forms the largest connected space of level ground in the whole island; not one lofty eminence or rocky ridge being found in several contiguous counties. The surface of Essex is not, however, totally flat, having many gentle hills and dales; and towards the north-west, whence most of the rivers proceed, the country rises, and presents a continued inequality of surface. The most level tracts are those of the southern and eastern hundreds. The sea-coast is broken into a series of islets and peninsulas, deeply cut in by arms of the sea, and exhibiting evident tokens of the force and effects of that restless element. Extensive salt marshes border most of the coast, the greater part of which is protected by embankments. The banks of the Thames, and the lower part near the sea, are likewise low and marshy. This county lies under a proverbial imputation of being particularly unhealthy; but this character can only apply to a small part of it; as the middle and northern districts are justly noted for a dry soil, and a wholesome clear air. That part known by the name of the hundreds of Essex, bordering on the south coast, from its low and marshy situation, and exposure

to the easterly winds and sea fogs, is certainly injurious to health, and many intermitting fevers proceed from these causes.

The principal productions of this county are wheat, barley, oats, beans, peas, turnips, tares, rape, mustard, rye-grass, and trefoil. Many districts on the east side are extremely productive; wheat is not unfrequently found to rise to a load an acre; oats, (particularly the Poland,) to eleven or twelve quarters; beans and other corn in proportion. Among the more rare plants cultivated in Essex, are those of coriander, teasel, and carraway; many acres are also appropriated to the produce of hops, and various horticultural plants and roots. The latter are confined to the vicinity of large towns, and to the lands adjoining to the metropolis. Almost every species of soil is to be found within the limits of Essex, from the most stubborn to the mildest loam. The north-west side is characterized by a chalky substratum; but the east and south sides abound with marshy and boggy land, having abundance of gravel intermixed. Of waste lands and forests, Messrs. Griggs (in their "General View of the Agriculture of Essex,") computed the county to contain fifteen thousand acres; the greater part of which, they observe, is capable of producing corn. Since their report, however, many districts have been inclosed and cultivated. Though Essex is not highly celebrated for its dairies, yet those in the parish of Epping and its vicinity are famous for the richness of their cream and butter. The butter is mostly sent to London, where it bears a high character and price. Few counties have less minerals than Essex; which is also nearly exempt from quarries, or any mass of rocks. In consequence, the houses are almost wholly built with brick; and many of them are singular and curious specimens of brick-architecture. In constructing the castles, the monastic buildings, and many of the old mansion-houses, the builders have endeavoured to render them not only durable monuments of their skill, but also examples of their taste, displayed by a variety of ornaments in the cornices, doors, pilasters, and particularly in the chimnies. Some mineral waters rise in the county, but few have obtained much repute; that of Tilbury is occasionally resorted to, and found to be impregnated with some earthy and muriatic salts.

The principal rivers, properly belonging to this county, are the Colne, the Blackwater or Pant, the Clelmer, the Crouch, the Ingerbourn, the Roding, and the Cam. Besides these, Essex partakes of other rivers, which serve as natural boundaries, and irrigate and fertilize its land: these are the Thames, the Lee, or Lea, the Stort, and the Stour.

In the early periods of our history, it is reasonably presumed, that the whole, or the greater part of Essex, was one extensive forest. During the British and Roman governments, many parts must have been cleared for stations, roads, and cultivation: yet in the time of king Stephen it appears that the principal portion of the county was either forest, or subject to forest laws. In his reign, however, a large tract in the north-east part of the county was disafforested, and cultivated; and the remaining part, north of Stane-street, was disafforested by king John. Henry the Third, in the twelfth year of his reign, directed perambulations to be taken of Waltham forest, in order to ascertain its extent and value; and about the same time had large tracts cleared for the plough. This judicious plan was pursued by Edward the First, in the twenty-sixth and twenty-eighth years of his reign: yet much forest land still remained; and Paul, viscount Bayning, with many other gentlemen of the county, purchased of the crown, and disafforested

several

Several parts of it. These proceedings, combined with the more equitable decisions of subsequent monarchs, occasioned the forests to contract their boundaries, and be less injurious to the public. While the forests continued in the crown, and were under the local government of arbitrary foresters and stewards, the subject, whose estate was contiguous, suffered repeated oppressions. The grievance was partly redressed in the perilous reign of king John, when the barons compulsively procured from that monarch the "Charter of Forests," by which many of these royal districts were disafforested, and stripped of their oppressive privileges; while more lenient regulations were adopted in the government of those that remained. The forests of Epping and Hainault still retain the name, and support a few deer, &c. The office of chief forester for Essex was deemed highly honorary, and was generally bestowed on some illustrious person. The stewardship was also an office of great consequence, and was usually enjoyed by some of the nobility. It continued in the De Veres, earls of Oxford, for many generations, but was taken from them by Edward the Fourth, on account of their adherence to the Lancastrian party. On the accession of Henry the Seventh, it was restored by grant to John, earl of Oxford. The steward had power to substitute a lieutenant, one riding-forester, and three yeomen-foresters, in the three bailiwicks of the forest. He also had many lucrative privileges, and was keeper of Havering at Bower, and of the house and park there.

Previous to the dissolution, Essex contained forty-seven religious houses; of these, two were mitred abbies; six common abbies; twenty-two priories; three nunneries; three colleges; two preceptories of templars; and nine hospitals.

Essex is included in the diocese of London, and contains three archdeaconries and fifteen deaneries; it returns eight members to parliament, *viz.* two for the county, two for Malden, two for Harwich, and two for Colchester; it is in the home circuit; pays twenty-four parts of the land-tax, and supplies 960 men for the militia.

ESSEX, one of the most populous and best cultivated counties in Massachusetts, in the United States of America; bounded N. by North Hampshire, E. and S. by the ocean, and the town of Chelsea in the county of Suffolk, and W. by Middlesex county; 38 miles long and 25 broad; of a triangular shape, Chelsea being the acute point. It is subdivided into 22 townships, containing 7644 houses, and 61,196 inhabitants, about 135 to each square mile. The first settlement in Massachusetts proper was made in Salem, the capital of this county, in 1628, and it was made a shire in 1643, being one of the three into which the colony was divided. Essex county pays about  $\frac{7}{8}$ th part of the state-tax, elects six senators for the government of the commonwealth, and two representatives in the legislature of the United States. The principal towns are Salem, Newbury-port, Gloucester, Marblehead, Beverly, Newbury, and Ipswich; and in it are two academies, one at Byfield, and another at Andover. The face of the county is agreeably variegated with hills, vales, plains, and woods; the land is generally fruitful, but more suited to the culture of barley than most other parts of the state; it has quarries of marble and limestone, and the coast is indented with a number of good harbours. The north part of Essex county is intersected by Merrimack river; and between it and the North Hampshire line is a strip of land three miles wide, divided into the towns of Methuen, Haverhill, Almsbury, and Salisbury, containing 1429 inhabitants. The chief island on the coast of this county is Plum island.

ESSEX, a county in Upper Canada, bounded on the E.

by the county of Suffolk, on the S. by lake Erie, on the W. by the river D'Etroit to Maissonville's mill, thence by a line running parallel to the river D'Etroit and lake St. Clair, at the distance of four miles; till it meets the river Thames, and thence up the said river, to the N.W. boundary of the county of Suffolk. This county sends one representative to the provincial parliament.

ESSEX, a county in Virginia, bounded E. and N.E. by Rappahannock river, which divides it from Richmond county; about 55 miles in length and 12 in breadth, and containing 3741 free inhabitants, and 5767 slaves.

ESSEX, a county in New Jersey, situated in the eastern part of the state, and separated from Staten island by Newark bay. It is about 25 miles in length and 16 in breadth, and has three townships, *viz.* Newark, Elizabeth-town, and Acquackanack, containing 22,269 inhabitants, of whom 1521 are slaves. The soil is fertile, and its productions find a ready sale in the city of New-York. This county comprehends seven Presbyterian churches, three for Episcopalian, one for Anabaptists, and two for Dutch Calvinists.

ESSEX, a county of New-York, having on the north Clinton county, on the south Washington county, and on the east lake Champlain, which separates it from Vermont.

ESSEX, a county in Vermont, bounded N. by Canada, and E. by Connecticut river, containing 1429 inhabitants.

ESSEX, a township in Chittenden county, in Vermont, containing 729 inhabitants, and lying between Jericho on the S.E. and Colchester on the N.W.

ESSEX Valley Mountains, mountains of the island of Jamaica; 10 miles S.S.E. of Lacovia.

ESSEY, a town of France, in the department of Orne, and district of Alençon; 3-leagues N.E. of Alençon.

ESSLISORS. See ELISORS.

ESSOIGN, or ESSOIN, in Law, an excuse for him who, being summoned to appear and answer to an action real, or to perform suit to a court baron, &c. cannot attend, because of some legitimate hindrance.

The word is formed of the French *essoine*, or *exoine*; and that from the barbarous Latin *essonia*, or *exonia*, which signifies the same.

The causes that serve to essoin, are various; yet they may be reduced to five heads. The first is, *essoin de ultra mare*, when the party is beyond sea; by which the defendant shall have 40 days: the second, *de Terra Sancta*, when on an expedition in the Holy Land, and the defendant shall have a year and a day; the third, *de malo veniendi*, when he is infirm of body, and cannot come; which is also called the common essoin; the fourth, *essoin de malo lecti*, when the defendant is sick a-bed, and may by writ be viewed by four knights; the fifth, *de servitio regis*, when he is in the king's service. Besides these, there are several other excuses to save a default in real actions, as constraint of enemies, floods of water, &c. 2 Co. Inf. 125.

ESSOIGN day of term, is the first day of that term when the court sits to take essoigns, or excuses, for such as do not appear according to the summons of the writ; *i. e.* the octave of St. Hilary, or the eighth day inclusive after the feast of that saint; which falling on the 13th of January, the octave, therefore, or first day of Hilary term, is the 20th of January. But the person summoned hath three days grace beyond the return of the writ, in which to make his appearance; and if he appear on the fourth day inclusive, the *quarto die post*, it is sufficient.

ESSOIGN de malo villa, is when the defendant is in court the first day, but gone without pleading; and being afterwards surprised with sickness, &c. cannot attend, but sends two essoigners, who openly protest in court that

he is detained by sickness in such a village, that he cannot come *pro lucrari et pro perdere*; and this will be admitted: for it lieth on the plaintiff to prove, whether the effoign is true or not.

ESSOIGNS, *Clerk of the*. See CLERK.

ESSOMMES, in *Geography*, a small town of France, in the department of the Aisne, on the river Marne; 3 miles S.W. of Château Thierry.

ESSONE, a river of France, in the department of Seine and Oise, which has its source near Pithiviers in the forest of Orleans, flows by Ferté Alais, receives the Juine near Saint Vrain, 3 miles above Villeroi, and falls into the Seine near Corbeil. It has lately been rendered navigable.

ESSONNE, a small town of France, in the department of Seine and Oise, near the river Essone, 24 miles S. of Paris, and 24 miles N. of Fontainebleau, remarkable for its manufactures of gunpowder and of writing paper.

ESSORANT, from the French *essorer*, to air, in order to dry, in *Heraldry*, a term used to express a bird standing on the ground with the wings expanded, as if it had been wet, and were drying itself.

ESSOYES, in *Geography*, a small town of France, in the department of the Aube, chief place of a canton in the district of Bar-sur-Seine, with a population of 1585 individuals, 15 miles S.W. of Bar-sur-Aube. Its canton contains 21 communes, and 11,655 inhabitants, on a territorial extent of 375 kilometres.

ESTABLISHMENT of *Dower*, in *Law*, is the assurance or settlement of dower made to the wife by the husband on marriage; and *assignment of dower* signifies the setting it out by the heir afterwards, according to the establishment. See DOWER.

ESTABLISHMENT of *Religion*. See RELIGION.

ESTACHE, is used in our *Old Writers*, for a bridge or flank of stone and timber.

ESTAFFLISCHEN, in *Geography*, a town of Poland, in the palatinate of Kalish; 14 miles N.E. of Kalish.

ESTAFORT, a town of France, in the department of the Lot and Garonne, and district of Agen; 3 leagues S. of Agen.

ESTAGEL, a town of France, in the department of the Eastern Pyrenées; 3½ leagues N.W. of Perpignan.

ESTAGNAC, a small town of France, in the department of the Charente; 33 miles E. of Angoulême.

ESTAIN. See ETAIN.

ESTAING, a small town of France, in the department of the Aveyron, chief place of a canton in the district of Espalion, with a population of 1075 individuals. It is situated 18 miles N. of Rhodéz. Its canton contains 12 communes and 6700 inhabitants on a territorial extent of 195 kilometres.

ESTAIRE, a small town of France, in the department of the North, on the river Lys, between Merville and Armentières; 15 miles W. of Lille.

ESTAMBOLIC, or ISTAMBOL-ANTIR, a town of Arabia, in the sheriffal of Mecca, near the coast of the Red sea; 180 miles N.N.W. of Medina.

ESTAMPES. See ETAMPES.

ESTANDARD. See STANDARD.

ESTANFORDE, in *Geography*, a town of Flanders; 12 miles S.W. of Ypres.

ESTAPA, or ISTAPO, a town of North America, in Mexico, and province of Tabasco, situated on a river of the same name; 10 miles S.W. of Villa Hermosa.

ESTAPLES. See ETAPLES.

ESTAPO, a strong town of America, in New Spain, inhabited by Spaniards and native Americans, situated at

the mouth of the river Tlaluc. N. lat. 17° 30'. W. long. 103° 5'.

ESTARREJA, a town of Portugal, in the province of Beira; 18 miles S. of Oporto.

ESTATE, in *Law*, the title or interest which a man hath in lands or tenements, &c. An estate in lands, tenements, and hereditaments, signifies (says judge Blackstone) such interest as the tenant hath therein; so that if a man grants all *his estate* in Dale to A. and his heirs, every thing that he can possibly grant shall pass thereby. (Co. Litt. 345.) It is called in Latin *status*, signifying the condition or circumstance in which the owner stands with regard to his property. For ascertaining this with accuracy, estates may be considered in a three-fold view: first, with regard to the *quantity of interest* which the tenant has in the tenement; secondly, with regard to the *time* at which that quantity of interest is to be enjoyed; and, thirdly, with regard to the *number and connexions* of the tenants.

I. The *quantity of interest* which the tenant has in the tenement is measured by its duration and extent. Thus, either his right of possession is to subsist for an uncertain period, during his own life, or the life of another man; to determine at his own decease, or to remain to his descendants after him; or, it is circumscribed within a certain number of years, months, or days; or, lastly, it is infinite and unlimited, being vested in him and his representatives for ever. This occasions the primary division of estates, into such as are *freehold*, and such as are *less than freehold*. See FREEHOLD.

Estates of freehold, understood as they are defined under that article, are either estates of *inheritance*, or estates *not of inheritance*. The former are again divided into inheritances *absolute* or fee-simple, and inheritances *limited*, one species of which is usually denominated fee-tail. See FEE-SIMPLE, and FEE-TAIL.

Of estates of freehold, not of inheritance, but *for life only*, some are *conventional*, or expressly created by the acts of the parties; others are merely *legal*, or created by construction and operation of law. As to estates for life, expressly created by deed or grant; see LIFE-ESTATE. As to the estate of tenant in tail after possibility of issue extinct; see TAIL and FEE-TAIL. As to tenant by courtesy, and tenant in dower; see TENANT and DOWER.

Of estates that are less than freehold, there are three sorts; *viz.* 1. Estates for years; 2. Estates at will; 3. Estates by sufferance. For the two former, see LEASE; and for the latter, see SUFFERANCE.

Besides the several divisions of estates above enumerated, in point of interest, there is another species which is called an estate *upon condition*; being such whose existence depends upon the happening or not happening of some uncertain event, whereby the estate may be either originally created, or enlarged, or finally defeated. (Co. Litt. 201.) Estates upon condition are of two sorts: 1. Estates upon condition *implied*; 2. Estates upon condition *expressed*: under which last may be included, 3. Estates held in *vadio, gage, or pledge*; 4. Estates by *statute-merchant* or *statute-staple*; 5. Estates held by *elegit*. See these several articles.

II. Estates, with regard to the *time of their enjoyment*, when the actual receipt of the rents and profits commences, may be considered either in *possession* or in *expectancy*; as to estates in possession, sometimes called estates *executed*, whereby a present interest passes to and resides in the tenant, not depending on any subsequent circumstance or contingency, as in the case of estates *executory*; all those above-mentioned are of this kind; but the doctrine of estates in *expectancy* contains, says Blackstone, some of the nicest and

most abstruse learning in the English law. Of expectancies there are two sorts; one created by the act of the parties, called a *remainder*; the other by act of law, and called a *reversion*. See *REMAINDER* and *REVERSION*. See also *EXECUTORY Devise* and *LIMITATION*.

III. Estates considered with respect to the *number and connexions* of their owners, or the tenants who occupy them, whatever be their quantity or length of duration, and whether they be in actual possession, or expectancy, may be held in four different ways: *viz.* in *severalty*, in *joint-tenancy*, in *coparcenary*, and in *common*. See *SEVERALTY*, *JOINT-TENANCY*, *COPARCENARY* and *PARCENERS*, and *TENANTS in common*.

With regard to the title to estates and the different modes of tenure; see *TITLE* and *TENURE*.

Estates are acquired divers ways, *viz.* by descent from a father to the son, &c. conveyance or grant from one man to another; by gift or purchase, deed, or will; and a fee-simple is the largest estate that can be in law. 1 Litt. 541.

Estates are real, of lands, &c. or personal, of goods and chattels; otherwise distinguished into freeholds that descend to the heir, and chattels, which go to the executors. The word estate, generally, in deeds, grants, and conveyances, comprehends the whole, in which the party hath an interest or property; and will pass the same. 3 Mod. 46.

ESTATE, *additions of*. See *ADDITION*.

ESTATE, *base*. See *BASE*.

ESTATE, *que*. See *QUE estate*.

ESTATE, or simple *State*, denotes also the empire, kingdom, provinces, or extent of lands under the government of any sovereign.

The estates of the grand seignor, of the king of Spain, &c. are very extensive; those of the king of France were before the revolution compact, and well peopled. Italy was formerly cantoned out into a great number of petty states. We say, ministers of estate, secretaries of state, &c.

ESTATE, or *State*, is also generally applied in the same sense with class or order; thus, the lay part of his majesty's subjects, or such of the people as are not comprehended under the denomination of clergy, may be divided into three distinct estates or states, the civil, the maritime, and the military. See each term.

ESTATE is more particularly applied to the several ranks or classes of a people assembled together, for concerting measures, reforming public abuses, or composing the disturbances of a state. In England, the three estates, *viz.* king, lords, and commons, meet ordinarily in parliament. See *PARLIAMENT*.

ESTATES *General*. } See *STATES General*, &c.

ESTATES *of Holland*. }

ESTAVAYER, in *Geography*, a small town of Switzerland, in the canton of Fribourg, pleasantly situated on the eastern shore of the lake of Neuchatel, N. lat. 46° 46'.

ESTE, a town of Italy, in the Paduan; 11 miles S.S.W. of Padua.

ESTELLA, a handsome manufacturing town of Spain, in Navarre, with an university in its neighbourhood, founded A.D. 1565. It contains several churches and convents, and 4500 inhabitants, defended by a castle, situated in a plain, watered by the rivers Ega and Ureder; 6 leagues S.W. of Pampeluna. The environs of this place are agreeable and fertile.

ESTELMUR, a town of Asiatic Turkey, in the province of Caramania; 120 miles S. of Cogni.

ESTENIDE. See *EKSENIDE*.

ESTEPA, a town of Spain, in the province of Seville,

or, according to some geographers, in that of Granada; celebrated for its olives and oil; 15 miles S. of Ecija.

ESTEPONA, a small fishing town of Spain, situated near the coast in the province of Granada, between Gibraltar and Marbella. Its territory furnishes abundance of wine.

ESTERLING, or *EASTERLING*. See *STERLING*.

ESTERNAY, in *Geography*, a small town of France, in the department of the Marne, chief place of a canton in the district of Epernay, with a population of 835 individuals. Its canton has 23 communes and 6498 inhabitants, upon a territorial extent of 325 kilometres.

ESTETE, in *Heraldry*, is used by the French to signify a beast whose head has been, as it were, torn off by force, and, consequently, the neck left rough and fugged; in contradistinction to *deffait*, or *decapité*, where the neck is left smooth, as if the head had been cut off.

ESTEVE, M. in *Biography*, a writer on the theory of music, or rather of sound or harmonics. He has attacked the demonstration of the principles of harmony by Rameau, in which M. Laborde allows him to have reason on his side: however, as he does not build his scale by the triple progression of Pythagoras, in the way which the abbé Rousfier prefers, and without which series of perfect fifth he thinks there never was nor ever can be any music fit to be heard, M. Esteve has not been honoured with the seal of Messrs. Laborde and Rousfier's approbation. He has, however, explained the cause of more and less perfection in concords, from the coincidences of vibration, which has been known ever since the time of Galileo, (see *BASSE fondamentale*), but never so clearly explained in France.

ESTHER, a canonical book of the Old Testament; denominated from a celebrated Jewish captive of that name, in Persia, whose beauty preferred her to the bed of Ahasuerus (supposed by some to have been Darius Hystaspis, by others Xerxes, but probably Artaxerxes Longimanus, though Jacob. Capellus makes him to be Ochus, called in Persia Achahsch-Verosh), and the throne of Persia; and who, in that quality, saved her countrymen, the Jews, from the death to which Ahasuerus had doomed them, by the counsels of his favourite Haman; who wished thus to be revenged on Mordecai for withholding from him that respect to which he conceived himself entitled. Mordecai informed the queen of the danger to which her nation was exposed; and induced her to wait upon the king, and invite him and Haman to a sumptuous banquet which she had prepared. Haman was puffed up with this high honour, and thought himself sure of accomplishing his ample scheme of vengeance. During the interval, the king chanced to read the public records, which reminded him of Mordecai's having discovered a conspiracy that had been formed against him. Determined to distinguish him by some signal token of favour, he ordered Haman to conduct Mordecai in triumph through the city. The queen having discovered to Ahasuerus, that she belonged to the Jewish nation, intreated justice against Haman on behalf of her people, for the destruction of whom he had obtained the king's decree. Ahasuerus ordered Haman to be hanged on the gallows which he had erected for the execution of Mordecai; revoked the decree issued forth against the Jews, and granted another, by which he permitted them to avenge themselves on their enemies on the day appointed. After the death of Haman, the king bestowed his estates upon Mordecai, and admitting him into his confidence, as the acknowledged uncle of the queen, advanced him to a station of high office and trust in his court. The history of this transaction makes the subject of the book of Esther. Edler was of the tribe

of Benjamin, and a descendant from one of those families, which had been carried into captivity by Nebuchadnezzar, king of Babylon, and afterwards settled in the city of Shushan. She was the niece of Mordecai, and her Jewish name was "Hadassah."

The critics are divided about the author of this book: St. Epiphanius, St. Augustine, and Isidore, attribute it to Ezra; but Eusebius will have it to be of a later date. Some ascribe it to Joachim, high priest of the Jews, and grandson of Josedek; others will have it composed by an assembly, or synagogue, of the Jews, to whom Mordecai wrote letters, informing them of what happened. *Esth.* ix. 29.

But the generality of interpreters, Hebrew, Greek, Latin, &c. ascribe the book to Mordecai himself; Elias Levita, in his *Maff. Hamum.* pref. 3. mentions this opinion as unquestionable.

It is chiefly founded on that passage, chap. ix. ver. 20. where it is said, that "Mordecai wrote these things, and sent letters unto all the Jews, that were in all the provinces, &c." It is also supposed that queen Esther herself might have some share therein: it being expressed in the same chapter, ver. 29. that Esther and Mordecai wrote a second letter, by the king's authority, to ordain the solemnizing a yearly feast, called *purim*, that is, *day of lots*, in commemoration of the Jews being delivered from the lots, or *sortes*, whereby they had been condemned.

Some will have this book to be deuterocanonical, or apocryphal; others contend for its being canonical, as far as chap. x. ver. 3. inclusive; and all the rest deuterocanonical. Of this sentiment are, St. Jerome, De Lyra, Dionysius the Carthusian, Cajetan, and others. The council of Trent turned the scale for its being canonical throughout; so that the matter is determined for the Catholic countries.

But the Protestants retain the old opinion, and only admit it as far as the third verse of the tenth chapter; the rest, to the end of the sixteenth chapter, is thrown among the apocryphal books. See CANON and APOCRYPHA.

ESTHER *Town*, in *Geography*, a town of America, in the county of Lancaster, and state of Pennsylvania, situated on the east bank of the Susquehannah river, a little N. of Harrisburg.

ESTHIO'MENOS, (from *estho*, to eat,) in *Surgery*, the disease called herpes exedens. Also any obstinate ulcer, which continues to eat away the parts.

ESTHONIA, in *Geography*, is the ancient name of the Russian government of Reval, on the southern coast of the gulf of Finland, over-against Finland Proper. In the year 1386 Esthonia was sold to the Teutonic order, and formed a part of Livonia; with which, after a separation of a hundred years, when it was under the dominion of Sweden, it was united to the Russian territory.

Not only the government of Reval, but also the greater part of Livonia, or five circles of the government of Riga, are inhabited by Esthonians. In the former they probably amount to 180,000, in the latter to 257,000 individuals. The language, manners, complexion, dwellings, and husbandry of the Esthonians prove their relationship to the Finns, who are one of the most far spread nations of the globe, extending from the shores of the Baltic to the remotest confines of Asia. In the Russian annals, where they act a considerable part, as they, in common with the Novgorodian Slavs, founded the Russian state, the Esthonians are called *Ishudes*. Tooke's *View of the Russian Empire*, vol. i.

ESTIÆA, *Εστιæα*, in *Antiquity*, solemn sacrifices to Vesta, called in Greek *εστιæα*, of which it was unlawful to

carry any away, or communicate any part to any beside the worshippers. Potter, *Archæol. Græc.* lib. ii. cap. 20. tom. i. p. 396.

ESTIATORES, *Εστιατορες*; among the Athenians, persons appointed by lot to provide an entertainment for the whole tribe. Besides those appointed by lot to this office, others voluntarily undertook it to ingratiate themselves. Potter, *Archæol. Græc.* lib. i. cap. 15. tom. i. p. 86.

ESTIMIONE, in *Natural History*, a name by which some call the *harmefion*.

ESTISSAC, in *Geography*, a small town of France, in the department of the Aube, chief place of a canton in the district of Troyes, with a population of 1255 individuals. Its canton has 6089 inhabitants, dispersed in 10 communes, on a territorial extent of 200 kilometres.—Also, a small town of France, in the department of the Dordogne, 18 miles N. E. of Bourdeaux.

ESTIVAL, a town of France, in the department of the Vosges, and district of St. Diey; 2 leagues N. of St. Diey.

ESTIVAL *occident*. See OCCIDENT.

ESTIVAL *orient*. See ORIENT.

ESTIVAL *solstice*. See ÆSTIVAL, and SOLSTICE.

ESTIVAREILLES, in *Geography*, a town of France, in the department of the Allier, and district of Montluçon; 5 miles N. of Montluçon.

ESTIUS, WILLIAM, in *Biography*, a learned Dutch divine, was born at Gorcum in Holland in the year 1542. He received the early part of his education at Utrecht, and finished his studies in philosophy and theology at Louvain, where he afterwards became an instructor. In 1580 he was admitted to the degree of doctor in divinity, and was successively chosen professor of theology, in the university of Douay; superior of that seminary, and afterwards its chancellor. He died in 1613 at the age of 71, while he was in the discharge of the various duties of his laborious office at Douay, highly esteemed on account of his modesty, piety, and active virtues. He had ever been indefatigable in his studies, and zealous in promoting the interests of those committed to his care. As an author his principal works are, "Commentarii in omnes S. Pauli et VII. Catholicas Apostolorum Epistolas," in two volumes folio. "Annotationes in præcipua ac difficiliora S. Scripturæ Loca." Another work is mentioned with much applause, it is a discourse "Contra Avaritiæ Scientiæ," intended to expose those who lock up their learning in their closets, and refuse to communicate it to the public by useful writings, or to individuals by well-timed and seasonable advice. The writings of Estius are recommended by Du Pin as exceedingly useful to young theologians in their enquiries after truth. Moreri.

ESTOILE'. A cross estoilé is a star with only four long rays, in manner of a cross; and accordingly broad in the centre, and terminating in sharp points.

ESTOILLE, PETER DE L', in *Biography*, who flourished towards the close of the sixteenth century, was educated to the profession of the law, and became grand audiencer of the chancery of Paris. He died in 1611, and after his death was published from his manuscripts "A Journal of the reign of Henry III." which has passed through many editions; of these the last was edited by the Abbé Lenglet du Fresnoi in 5 vols. 8vo. The same learned editor gave to the public "L'Estoille's Journal of the reign of Henry IV." in four volumes, 8vo. This, as well as the other work, is enriched by some curious pieces not to be found in the preceding editions. The style and manner of these journals possess much simplicity, exhibiting the air of

truth,

truth, and affording a lively and accurate picture of the times. Moreri.

ESTOILLE, CLAUDE DE L', son of the preceding, was a poet, and admitted a member of the French academy in the year 1632. He was patronized as a dramatic writer by Richlieu, but his pieces were not well received by the public, though he is allowed to have had a talent at versification, and a thorough knowledge of the rules of the stage. He was a rigid censor of his own performances, and of those of others, and is said to have occasioned the death of a young author by the severity of his criticism on a comedy put into his hands. He died in 1652 about 50 years of age. He had obtained, and richly deserved, the character of an honourable and truly independent man. In the earlier part of life, though ill provided for with respect to fortune, he chose to quit the capital with a wife whom he loved, rather than submit to the meannesses which men of letters are too much inclined to practise in courting the opulent. Moreri.

ESTOPPEL, formed of the French *estouper*, *oppilare*, *obstipare*, to stop, or block up, in *Law*, an impediment, or bar of action, arising from a man's own act, or deed; against which a man is forbidden, by law, to speak, though it be to say the truth. See BAR.

Goddard defines an estoppel to be any bar, or hindrance, to one to plead the truth; and extends it not only to the impediment given by his own act, but by another's also. There are three kinds of estoppel; *viz.* by matter of record, by matter in writing, and by matter in pais.

ESTOVERS, is used by Bracton, (l. iii. tr. 2. c. 18.) for that sustenance which a man, committed for felony, is to have out of his lands, or goods, for himself and his family, during imprisonment.

In stat. 6 Edw. 1. it is used for an allowance in meat, or cloaths. In some manors the tenants have common of estovers; that is, necessary botes, or allowances, out of the lord's wood; in which last sense, estovers comprehends house-bote, hay-bote, and plow-bote; so that if a man have in his grants these general words, "de rationabili estoverio in boscis, &c." he may thereby claim all three.

Estovers is also used for alimony, which if the husband refuses to pay, there is, besides the ordinary process of excommunication, a writ at common law, "de estoveriis habendis," in order to recover it.

ESTOURMELLES, in *Geography*, a town of France, in the department of the North, and district of Cambray;  $1\frac{1}{2}$  league E. of Cambray.

ESTOUTEVILLE, a small town of France, in the department of the Lower Seine, 12 miles N. of Caudebec.—Also, a small town of France, in the same department, 15 miles N. of Rouen.

ESTRAC, in the *Manege*, signifies a horse that is light bodied, lank-bellied, thin flanked, and narrow-chested. See BELLY.

ESTRADE, a French term, literally signifying a public road, or highway. Hence the military phrase, *battre l'estrade*, to beat the estrade, that is, to send scouts, or horsemen to get intelligence, to learn the dispositions of the enemy, and inform the general of every thing likely to fall in the way. An army never marches without sending batteurs d'estrade on every side.

The word is formed of the Italian *strada*, street, or road; which is derived from the Latin *strata*, a paved street. Some derive it from *estradiots*, who were cavaliers anciently employed in beating the estrade.

ESTRADE is also used for a little elevation of the floor of a room, frequently encompassed with an alcove, or rail, for

placing a bed in; and sometimes, as in Turkey, only covered with fine carpets, for receiving visitors of distinction.

ESTRADES, GODFREY Count of, in *Biography*, was at an early age designed for the profession of arms, and served under prince Maurice in Holland, with whom he acted as agent of the French court, and afterwards attained the high honour of marshal of France. He was highly esteemed as a diplomatic character, and in the year 1661 went to England as ambassador extraordinary, where he maintained with spirit the precedence of the crown of France to that of Spain. In the following year he went to Holland in the same character, and concluded the peace of Breda. He was intrusted with the important negotiation for a general peace at Nimeguen, and acquitted himself to the satisfaction of all concerned. He sustained with high reputation various other diplomatic characters, and in 1685 was nominated governor to the duke de Chartres, but died within a few months, at the age of seventy-nine. The count left behind him an abundance of MSS. concerning the different negotiations in which he had been engaged: from these, which consisted of twenty-two volumes folio, a collection was published in 1709, entitled "Letters, Memoirs, and Negotiations of the Count d'Estrades." An improved edition was published in 1743 at the Hague, in 9 vols. 12mo.

ESTRANGEL, ESTRANGELUS, in the Syriac *Grammar*. Estrangel character, is a particular species, or form, of Syriac letter; serving as the majuscule letters in that language.

Abraham Echellenfis takes the estrangel character for the true ancient Chaldee characters; and it is certain the Abyssinians, who call themselves Chaldeans, still occasionally use the estrangel character, if we may credit Hottinger, in his *Theaur. Philol.* p. 286. Bishop Walton, in his *Prolegomena*, gives us an estrangel alphabet.

ESTRAPADE, in the *Manege*, is the defence of a horse that will not obey, but to get rid of his rider, rises much before, and while his forehead is yet in the air, yerks furiously with his hind legs, striking higher than his head was before; and during his countertime goes back rather than advances.

ESTRAY, or STRAY, signifies any tame beast, or sheep, oxen, swine, and horses, or swans, found within a lordship, and not owned by any man; in which case being cried, according to law, in the church, and two market-towns adjoining, if it be not claimed by the owner, within a year and a day, it becomes the lord's of the soil where found. If the owner claims it within the year and day, he must pay the charges of finding, keeping, and proclaiming; and he may seize it, without telling the marks, or proving his property, which may be done at the trial if contested. If the beast stray within the year to another lordship, the first lord cannot retake it. An estray must be fed and kept, uninjured, and without labour, till it is reclaimed, or the limited time expires.

ESTREAT, EXTRACTUM, in *Law*, is used for the true copy, or duplicate, of some original writing, especially of amercements, or penalties, set down in the rolls of a court, to be levied by the bailiff, or other officer, on every offender. Justices, commissioners, &c. are to deliver their estreats into the exchequer yearly, after Michaelmas; and fines to have writs, which shall be entered in the estreat, in order as they are entered in the chancery rolls, &c. stat. 5 Hen. III. stat. 5. 16 Edw. II. All forfeited recognizances are to be first estreated in the exchequer by sheriffs of counties; on which process issues to levy the same to the use of the king. Stat. 22 and 33 Car. II. cap. 22.

Sheriffs' estreats must be in two parts, indented and sealed by the sheriff, and two justices of peace; who are to view them, and one of them is to remain with the sheriff, and the other with the justices. Stat. 11 Hen. VII. c. 15. The estreats of fines, at the quarter-sessions, are to be made by the justices; and to be double, one of which is to be delivered to the sheriff by indenture. Stat. 14 R. II. c. 2. Fines, post-fines, forfeitures, &c. must be estreated into the exchequer twice a year, on pain of 50*l*. And officers are to deliver in their returns of estreats upon oath. Stat. 22 & 23 Car. II. c. 22. 4 and 5 W. & M. c. 24. It is the course of the court of B. R. to send the estreats into the exchequer twice a year, *viz.* on the last day of the two issuable terms; but in extraordinary cases there may be a rule to estreat them sooner. 1 Salk. 45.

ESTREATS, *Clerk of the*. See CLERK.

ESTREES, FRANCIS-ANNIBAL D', in *Biography*, was born in 1573, and educated for the church, in which he had the bishopric of Noyon conferred upon him by Henry IV. at a very early age. When he was only twenty-one he resigned his ecclesiastical preferment, on account of the death of his elder brother, and assumed the profession of arms, in which he became distinguished under the title of the marquis De Coevres. He was ambassador extraordinary to Switzerland and the princes of Italy, in 1614. He was created marshal of France in 1626, and in 1630 succoured the duke of Mantua, who was besieged in his capital. In 1636 he was deputed ambassador extraordinary to Rome, a character in which he well supported the honour and interests of his crown in opposition to pope Urban VIII., with whom, and the nephews of the haughty pontiff, he was continually involved in quarrels. He was recalled by his own sovereign, which he considered as an affront, and refused to appear at court, to give an account of his conduct. He died at Paris in 1670, at the great age of ninety-eight years, highly respected by his countrymen. At the desire of cardinal Richelieu, he drew up "Memoirs of the Regency of Mary de Medicis," which was published at Paris in 12mo. in the year 1660. "A relation of the Siege of Mantua, in 1620," and "An Account of the Conclave, in which Pope Gregory XV. was chosen in 1621," have also been given to the public from his papers. Moreri.

ESTREES, CÉSAR D', son of the preceding, was born in 1628, and being brought up to the church, he was raised to the bishopric of Laon in 1653. He was created cardinal by Clement X. in 1671; and at the death of that pontiff entered the conclave, and managed so as to put off the election five weeks, till the arrival of the other French cardinals. He was sent into Bavaria to negotiate the marriage of the dauphin in 1677, and afterwards went to Rome, on other important and difficult business. He supported the rights of the crown, and of the Gallican church in opposition to pope Innocent XI., whom he prevented from publishing any act infringing on both. He resided many years at Rome, the sole resident on the part of France, and exerted much influence at the election of succeeding popes. On his return to France he was rewarded with the rich abbey of St. Germain des Pres, where he died in 1714, in his eighty-seventh year, greatly regretted, &c. leaving behind him a high character as a politician. Moreri.

ESTREES-Saint-Denis, in *Geography*, a small town of France, in the department of the Oise, chief place of a canton, in the district of Compiègne, with a population of 1040 individuals. The canton has a territorial extent of 150 kilometres, with 20 communes, and 10,325 inhabitants.

ESTREMADURA, *i. e.* *Extrema Durii*, a province of

Portugal, bounded on the north by Beira, on the east and south by Beira and Alentejo, on the west by the ocean; lying between 38° and 40° N. lat. and obliquely between 7° 10' and 9° 30' W. long.; being 140 miles from north to south, and 70 in breadth; containing 5,440 square miles, 8 jurisdictions, 400 parishes, and 350,760 inhabitants. Several districts of this province are abundantly fertile, yielding grain, wine, oil, and fruits. The whole country is covered with flowers, and the bees produce a great quantity of honey. The manufacture of salt affords one of the chief articles of commerce. The principal towns are Lisbon, Leiria, Abrantes, Pombal, Alcobaca, Setuval, Thomar, Santarem, Alanquer, Torres Vedras, Cintra, and Cascaes; and the chief rivers are the Tagus, or Tajo, and the Sador or Sado, sometimes called Cadaon and Caldas.

ESTREMADURA, a province of Spain, bounded on the N. by Leon; on the E. by New Castile; on the S. by Andalusia; and on the W. by Portugal; lying between 38° and 40° N. lat.; and between 7° 10' and 4° 40' W. long.: being 140 miles from north to south, and 90 — 100 from west to east. This province was formerly a part of Portugal, but being separated from that country, it is sometimes called Estremadura of Castile. It is traversed by the rivers Guadiana and Tajo, which divide it into three equal parts. Intersected by ridges of hills, it abounds in grain, fruits, and excellent pastures; but good water is scarce, and the air in summer is exceedingly hot, insupportable to strangers, but to the natives not insalubrious. The principal commerce consists of cattle and fine wool; and the hills are covered with oaks, the acorns of which feed large herds of swine, that are black. The inhabitants are in general inclined to corpulency; and are considered as humane, affable, sincere, stout, and brave. The principal towns are Badajoz, Placentia, Coria, Albuquerque, Cáceres, Truxillo, Merida, Montejó, Xeres de los Cavalleros, Ellereña, and Zafra; and the chief rivers are the Guadiana, the Tajo, and the Alagon.

ESTREMERÁ, a town of Spain, in New Castile; 27 miles S.E. of Madrid.

ESTREMOZ, a fortified ill-built town of Portugal, in the province of Alentejo, containing three churches, six convents, two hospitals, and 6500 inhabitants; pleasantly situated on a rising ground in a fertile country; 7 leagues N.E. of the capital; and famous on account of a victory gained by the Portuguese over the Castilians, in the year 1663. In its vicinity there is excellent marble. The country on the west side of the town is pleasant and well cultivated, abounding in orange gardens and laurels; but at some distance no traces of cultivation appear. This town has a manufacture of beautiful earthenware.

ESTREPAGNI. See ETREPAGNY.

ESTREPEMENT, in *Law*, an impoverishing or making of land barren, by continual plowing and sowing, without due manuring, rest, and other husbandry.

The word is derived from the French *estropier*, to maim; or the Latin *extirpare*, to extirpate, root up.

ESTREPEMENT is also used for any waste, or spoil, made by the tenant for life, upon lands or woods, to the prejudice of him in reversion; as the cutting down of trees, or lopping them farther than the law allows, &c.

ESTREPEMENT is also a writ which lies in two cases: the one, by the stat. of Gloucester, 6 E. I. c. 13, when a man having an action depending, as a formedon, writ of right, or the like, sues to inhibit the tenant from making waste during the suit.

The other is for the demandant, who is adjudged to recover seisin of the land in question; and before execution,

for fear of waste to be made till he can get possession, sues out his writ.

**ESTRICH**, or **OESTRICH**, in *Geography*, a town of Germany, in the circle of the Lower Rhine, and electorate of Mentz on the Rhine; 14 miles W. of Mentz.

**ESTUCUA**, a town of Mexico, in the province of Mechoachan; 58 miles W. of Mechoachan.

**ESULA**, or **ÆSULUM**, in *Ancient Geography*, a town of Italy, situated on a mountain, near the Tiber.

**ESULA**, or *Æsula*, in *Botany*, a word said to be of Arabian origin. See **EUPHORBIA** *Esula*, and **APOCYNUM** *Venetum*.

**ESULÆ RADIX**, in the *Materia Medica*, the name of a root of a plant of the spurge kind, sometimes used in medicine. The root consisting of a cortical part, and an inner sticky one, the bark only is used; and such should be chosen as is new dried, and of a reddish colour without and within, and such as, when held in the mouth, affords a very disagreeable taste, with great acrimony. It is a very violent purge, and has been said to have performed cures in dropical cases, when more gentle medicines have proved ineffectual. It is a good method to macerate it a day or two in vinegar before it is used.

**ESURIS**, in *Ancient Geography*, a town of Spain, supposed to be *Xeres*.

**ESUS**, or **HESUS**, in *Mythology*, a deity among the Gauls, to which they sacrificed after victory whatsoever came alive into their possession. They sometimes sprinkled the altars of this deity with the blood of their women and children.

**ESZEK**, in *Geography*, a town of Slavonia, with a wooden bridge, built by the Turks over the Drave; 48 miles W.N.W. of Peter-Waradin, and 80 N.W. of Belgrade.

**ETABLES**, a town of France, in the department of the North Coasts, and district of St. Brieu; 2½ leagues N. of St. Brieu.

**ETAIN**, or **ESTAIN**, a small town of France, in the department of the Meuse, chief place of a canton in the district of Verdun, 18 miles N.E. of Verdun. It has a population of 2300 individuals, and its canton comprises 30 communes, with 7125 inhabitants, on a territorial extent of 247½ kilometres.

**ETALLE**, a small town of France, in the department of the Forêts, chief place of a canton in the district of Neufchâteau, with a population of 1080 individuals. Its canton has a territorial extent of 280 kilometres, and 13 communes, with 9013 inhabitants.

**ETAMPES**, a small town of France, in the department of Seine and Oise, chief place of a district of the same name, with a population of 7786 individuals. It is situated on the left bank of the river Juine, at the confluence of two other rivulets, 36 miles E. of Chartres; 45 miles N. by E. of Orleans; and 40 miles S. of Paris. N. lat. 48° 25'. The canton contains 14,187 inhabitants, dispersed in 15 communes, on a territorial extent of 192½ kilometres.

As chief place of a district, Etampes has a sub-prefect, a court of justice, and a register office. There are some manufactures of hosiery, woollen, and cotton yarn, and leather. The stockings, in particular, are known in the French trade by the name of stockings of Beauce, or Bas de Beauce, from the village where the best are made.

The soil of the district of Etampes is sandy: it produces, however, some wheat, rye, barley, oats, and hemp. There are a few vineyards and some artificial meadows. The district contains 6 cantons, 111 communes, 1372½ kilometres, and 58,890 inhabitants.

**ETANGS**, **LES**, a town of France, in the department of the Moselle, and district of Boulay; 2½ leagues E.N.E. of Metz.

**ETAPLES**, or **ESTAPLES**, a small town of France, in the department of the Pas de Calais, chief place of a canton in the district of Montreuil, with a population of 1360 individuals. It is situated at the mouth of the river Canche, which forms a small harbour, 12 miles N.E. of Boulogne, 168 miles N. of Paris. N. lat. 50° 30' 44". The canton contains 19 communes, and 7807 inhabitants, on a territorial extent of 232½ kilometres.

**ETAPPE**, in *War*, an allowance of provisions and forage made to the soldiers upon march through a kingdom, or province, to or from winter quarters.

Hence, he that contracts with the country, or territory, for furnishing the troops in their march, is called *etappier*.

**ETARRY**, in *Geography*, a town of Hindoostan, in the country of Bahar; 34 miles S.W. of Arrah.

**ETAULIERS**, a town of France, in the department of the Gironde, and district of Bourg; seven miles N. of Blaye.

**ETASAGGAH**, a town of Hindoostan, in Bahar; 35 miles S.E. of Bahar.

**ETAVERAM**, a town of Hindoostan, in the Carnatic; 10 miles E. of Coilpetta.

**ETAYA**, a circar of Hindoostan, in the Soubah of Agra, bounded on the N. by Rohilla; on the E. by the circar of Pattan, Canoge an Corah, and on the S.W. by Jumna. Etaya is the capital.

**ETAYA**, a town of Hindoostan, in the country of Agra, on the N.E. side of the Jumna, 52 miles S.E. of Agra. N. lat. 26° 45'. E. long. 79° 17'.

**ETCH**, in *Agriculture*, a term signifying the same thing as *ersh*. See **ERSH**.

**ETCHAUK**, in *Geography*, a town of Bengal, 22 miles N. of Ramgur.

**ETCHING**, in the *Polite Arts*, an important branch of that species of engraving which is performed with the view of delivering impressions on paper, by means of the rolling-press, is the superaddition of the chemical process of corrosion, to the art of drawing through etching-varnish, (or etching-ground, as it is more frequently termed,) on plates of metal; though it has sometimes been successfully performed on other substances, and particularly on glass.

Etching is most frequently performed on plates of copper; and (though aqua-tinta be a species of etching, for which see **AQUA-TINTA**) the means commonly employed, are lines drawn with a stylus, or steel-point, termed an etching-needle, which are afterwards corroded by aqua-fortis.

The etching-needle resembles the dry point (see the article **DRY-POINT**) in all respects, excepting the superior sharpness of the latter, and that it need not be quite so long as dry-points are at the first. Of these needles, the artist should provide himself with three or four, for etching finer or coarser lines, of various dimensions and different degrees of bluntness; that for the finest or most delicate lines being little less sharp than the dry-point. That he may with certainty etch lines of similar strength and depth, where such are required, as in covering a surface of an even tint, the extreme point of his needle should be very delicately and gradually rounded off on a leathern strop supplied with crocus-martis, or putty-powder.

The practitioner in etching should, moreover, provide himself with a soft and large camel's-hair brush, wherewith occasionally to sweep the dust, and erased etching ground, from the surface of his work: and an etching-board of from three to six inches in breadth, bevelled to an edge on one side, supported at the ends by small bars of wood about one-third of an inch in thickness, and of sufficient span to stand as a bridge over the varnished plate, and prevent the engraver's hand from touching and marring his work, should also be provided,

provided, and the copper-plate, being previously prepared, as see COPPER-PLATE, he may proceed to lay his etching-ground in the following manner.

The plate is put upon a German stove, or chafing-dish, and heated over the fire; or, if small, is held with a hand-vice, the polished side being upwards, and heated with the flame of paper burning under it; when hot, it is rubbed over with etching varnish (such as is described in the sequel of this article) wrapped up in taffety, which should be gently passed from one side to the other in a right line, so as to form several rows, till the plate is every where moderately covered; then with a *dabber*, formed of cotton, tied up in Persian silk, let every part of the plate be beat gently, while the varnish is in a fluid state; and in order to give it a fine grain, and that the varnish may be equally spread over the surface of the plate, continue to beat it with the dabber, after the plate is taken from the fire; till it attains a somewhat harder consistence in cooling; but the use of the dabber should be discontinued long before the varnish is cold, lest it should be made to rise from the plate.

When the plate is thus uniformly and thinly covered with the varnish, it must be blackened whilst it is yet warm by a piece of flambeau, or of a large wax-candle, or taper, twitted together, till six or more flames unite in one, which affords a copious smoke; dispatch is of importance, that the varnish may not grow cold during the operation, which should be performed, if possible, at one heating of the plate, for repeated melting of the varnish does it much damage. Large plates may be suspended from the ceiling of a room by four cords and iron rings, with the varnished side downwards, for the greater convenience of being blackened. Care should be taken that the flambeau or candles be kept at a proper distance from the plate, that the wick may not touch and burn, or otherwise impair the varnish. The varnish may be made white, if that colour is preferred to black, by grinding white lead in water, and putting it into a glazed earthen dish, with a little good glue dissolved, and melting the whole together. This mixture is spread with a brush or pencil of hog's hairs thinly and evenly on the varnish laid on the plate and smoothed. The colour is then left to dry; if it fixes with difficulty on the varnish, the composition should be mixed with a drop or two of ox-gall.

When the copper-plate is thus varnished, and is quite cold, it remains to transfer from paper to the varnished plate, the tracing, or outline of the design. If the outline be reduced from an oil or water-colour picture or other original of larger dimensions than the intended etching, and be executed with lead pencil or red chalk upon drawing or writing paper, the method most in use among English engravers, is, to take the varnished plate and outline to the rolling-press printers, and (suffering the latter to lie between wetted paper for a quarter of an hour or so, that it may become sufficiently damp for the lead or chalk to be in a certain degree liquified, while the paper is sufficiently softened to do no injury to the etching ground,) to pass it through the press, the upper roller thereof being supplied with blankets in the same quantity, and the press adjusted to about the same degree of pressure, as for printing. If this be carefully performed, the outline will appear at once transferred, and reversed on to, the surface of the etching-ground, and the artist have nothing to do but to proceed with his etching. By these means the trouble both of retracing and *reversing* (*i. e.* of changing the right hand view of his picture round to the left, and *vice versa*, the left to the right, as it would appear if reflected in a looking-glass,) is saved to the engraver. The method formerly used,—which must ever be used where no rolling press is at hand,

and which is still believed to be generally practised in the other countries of Europe—is, either to trace the outline of the design on transparent paper, that by simply turning the paper it may be seen in reverse, or using thin drawing paper for the purpose, to render it transparent afterwards by means of oil or varnish. When this is thoroughly dry, a piece of fan, or other very thin, paper, of the size of the outline to be traced, must be evenly rubbed over on one side with powdered red chalk or black lead, and interposed between the outline and varnished plate, with the chalked or leaded side downward, and both outline and tracing paper being stretched tight over the varnished plate, and fastened by means of small bits of wax placed along the margin, a blunt etching-needle must be carefully passed over the several outlines with a moderate degree of pressure, which will occasion so much of the powdered lead or chalk to adhere to the smoked etching ground, as, when the papers are removed, will exhibit the outline or tracing of the whole design in all its correctness.

Having proceeded through these introductory mechanical preparations, which require care and some knowledge of drawing, the engraver's task as an artist, or man of taste or genius, properly begins. Who shall prescribe laws to genius?—He may now exercise the knowledge he has previously stored, and call forth his inventive powers. The forms of his objects must now be severally drawn, with such taste and feeling as he may possess; and his shadows, demitints, and lights, excepting such as he may prefer to leave to be executed by the graver or dry point, be hatched, by employing lines more close or more open, and pressing on his needles more lightly or more strongly, as a skilful musician presses on the keys of his harpsichord, and as the several parts of his work may demand, varying his line with the nature of his object.

The characteristic, or local advantage of etching, for certain purposes, over lines cut with the graver, consists in the unlimited freedom of which this mode of art is susceptible. The etching-needle, meeting little resistance from the varnish, glides along the surface of the plate, and easily takes any turn that the taste of the artist may direct, or his hand accomplish; and hence its peculiar adaptation to the expression of that class of objects which artists term *picturelike*, such as trees, rocks, ruins, cottages, the shaggy hair of animals, broken ground, or other rough and irregular surfaces.

It has formerly been much disputed among the curious, whether Germany or Italy had the honour of giving birth to the invention of etching, and with the view of ascertaining this point, the dates of the impressions from the earliest etchings by Albert Durer and Parmegiano have been assiduously sought for and compared. The writer of the present article conceives that some portion, at least, of this discussion and research, might have been spared, had the disputants reflected that etching, originally *Etzen*, is not an Italian but a German word, and how very unlikely it is that an Italian invention should have been denominated by a German word.

Although this art afforded means analogous to the objects themselves, of drawing and characterising all those objects, of which wildness and freedom, communicated by spontaneous perception and feeling, is the soul, yet engraving with the graver had been previously invented, and in the beginning of the sixteenth century impressions from such engravings had called forth the admiration of the tasteful. For these reasons, and from the prevalence of those habits, and prejudices of taste and education, which hang like dark veils about the faculties of man, the extent and variety of energy of which etching was capable were not perceived,

and probably are not even yet perceived; the means of engraving, or manual operation of the graver, was mistaken for the end; and hence a false criterion of merit obtained considerable influence; connoisseurs gravely put on their critical spectacles in order to see in what degree, and how dexterously, the etcher had imitated the clear and clean-cut lines of the graver; just as the early printers with the letter press, merely endeavoured to imitate M.S. missals and bibles, without perceiving the superior degree of perfection of which printing was susceptible. The Saddlers, Le Bosse, and others run into this egregious mistake, and the latter, who wrote a treatise on the art of engraving, lays it down as a principle, that the perfection of this mode of engraving consists in the close similitude of etching to the work done by the graving-tool.

That the efforts of the most tasteful, bold, and inventive among the engravers of our own country, have largely contributed to dispel these prejudices, will be seen towards the close of this article. At present we proceed with our account of the process of etching.

The forms of the several objects of which any given etching may consist, being drawn with requisite knowledge and care, and the chiaroscuro, and expression of the textures of the several substances introduced into the composition, hatched with the degrees of taste and truth, which the ability of the artist may enable him to display, the business of corrosion, which is technically called *Biting-in*, begins. For this purpose a border of such wax as is of a moderate degree of hardness when cold, and of a moderate degree of tenacity whilst warm, must be applied round the margin of the plate, in the form of a little wall or rampart, about an inch, or three quarters of an inch in height. This wax may be composed of bees' wax, either tempered with common pitch, or with Venice turpentine and tallow, and at one of the corners a gutter, or spout, should be formed for pouring the aquafortis conveniently off the plate. The plate being thus bordered, it is usual further to fortify or secure the work against the egress of the aquafortis whilst biting, by turpentine-varnish thickened with lamp-black, and applied with a hair pencil on the margin of the plate, and under the inside edge of the rampart of wax. This varnish or composition (which is called *stop-ground*) being sufficiently dry, the aquafortis may be poured on the plate.

We are now arrived at a part of the process where experience, combined with chemical knowledge, is the only practical guide on which any thing like sound reliance may be placed. Yet a few general rules may not be dispensed with. The aquafortis may either be pure nitrous acid, diluted with pure water in the proportions of four or five parts water to one of nitrous acid for the more delicate parts of the etching, or it may be the double aquafortis of the shops diluted with pure water in the proportions of two to one, or sometimes of equal parts, according to the degree of strength or delicacy of the faintest parts of the work. Of aquafortis thus diluted, but which must be gradually strengthened as the work proceeds, let a sufficient quantity be employed to rise, when poured on the plate, about half an inch above its surface. If all things have been rightly conducted, it will now be seen that the menstruum will soon exert its action in those lines or hatches where the artist has pressed hardest on his etching-needle, and will gradually begin to corrode the more delicate lines. It may here be proper to observe that a feather, or camel's hair brush, should be used during the biting, to burst the small bubbles of fixed air which are liberated from the copper, and cleanse away from the lines the verdigrise which is generated during the operation of the aquafortis: by thus moving the

aquafortis to and fro on the plate, it will exert its action uniformly over the whole etching.

In about a quarter of an hour, or when the effects of the aquafortis have become visible in the more tender parts, it may be poured off, the plate washed with clean water, and dried by exposure to the air, sunshine, or (which is now more common, because more expeditious) by the operation of a pair of bellows. After trial made by taking off a small portion of the etching-ground with the scraper, or a small piece of pointed charcoal, such parts of the etching as are believed to be sufficiently corroded, must be painted over carefully, or *stopped-out*, with the composition of lamp-black and turpentine varnish which is mentioned above; and when this is dry, the aquafortis must be re-applied, and the biting proceeded with in the same manner, till the stronger parts are judged to be sufficiently corroded, the aquafortis being strengthened from time to time according to the judgment of the operator.

To bite-in a large plate will sometimes occupy several days, for great judgment and nicety of observation are required in gradating the chiaroscuro, and considerable care must be exerted in the stopping-out. It need scarcely be mentioned, that the operator should be as cautious as the necessary degree of attention to his work will allow, not to inhale the fumes which arise from the mingled copper and aquafortis, which become more and more deleterious, as the biting advances.

When the strongest parts are believed to be sufficiently corroded, and the plate is thoroughly washed with water, it may be again placed on the chafing dish, or German stove, till it be sufficiently warm for the border of wax to be removed, after which, and while it is yet warm, the varnish may be diluted by the application of a small quantity of oil of turpentine or of olives, and wiped off with a rag; when, if the biting-in hath been successfully accomplished, the etching is complete, and in some cases the plate is finished; though in most cases it happens that the engraver's taste and judgment direct him purposely to leave certain parts to be finished with the dry point and graver.

For an account of the early progress of the art of etching, the reader is referred to our account of the GERMAN and ITALIAN schools of engraving. Its more recent improvements have taken place in England. In etching trees, which no other mode of engraving can adequately express, Vivares and Pouncy have displayed an art of characterizing the species of tree which it was their object to represent, and at the same time of suggesting in the varying styles of their foliage, those masses or countless numbers of leaves which are seen in nature itself. Their etchings of trees are decidedly superior to those which have been produced on the continent, unless we might except the trees of Waterloo and Kobell, and have rarely been equalled by those of the engravers of our own island.

He who would see the most perfect specimens which have been produced of this species of art, should look at aquafortis proofs (not the finished engravings) which Vivares has produced after Claude, Patel, and Gainsborough; and those which Pouncy has etched after Wilson, Hearne, and Farington. In looking at the former, he will see with surprise how much Vivares has attained of the peculiar beauty, feeling, and delicacy of Claude's pencil, although he could only have been acquainted with certain pictures:—the larger Colonna Claude for example, from which he has produced a most exquisite etching—through the medium of chalk drawings, and those not very good. It is not less worthy of admiration, at least of high approbation, to observe how truly Pouncy has characterized the painting of Wilson, in

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his etchings of "Athens in Prosperity," and "Athens in Ruin," which are also executed from chalk drawings copied from the originals of Wilson in the library of the late Mr. Willett.

In rocks and cottage subjects Browne has scarcely been less successful, as may be seen in the aquafortis proofs of the best of his large plates after Both, Salvator Rosa, and Du Sart. In the rocks of his "St. John preaching," after Salvator Rosa, he is perhaps somewhat extravagant, and out of harmony with his own figures and foliage, though vigorous and characteristically rugged; but in "the Cottagers," and "the Jocund Peasants," after Du Sart, he is unrivalled; the several textures of the old plaster walls, old planks, thatch, broken ground, rough coated animals, (though these are probably etched by Woollett,) and even the flush which trickles down the hog-trough, are etched with the truest feeling of nature and Du Sart.

In etching ruins, as well as more perfect architectural subjects, Piranesi the Roman led the way, and Rooker the elder successfully followed. These artists more than perhaps any other, except Mr. Lowry, shewed the affinity, or susceptibility of picturesque union, which subsists in fine art, between freedom of handling and geometrical precision; as may be seen with pleasure in the antiquities of Rome and Pæstum, which Piranesi etched from his own drawings; (the original and very masterly drawings of the temples at Pæstum being preserved in the collection of Mr. C. Lambert of the Temple F. A. S.) in the six large views of London, which Rooker etched after the drawings of P. Sandby and himself; and among numerous other works from the hand of Mr. Lowry, in the plate of the west door of the cathedral of Carrara from the drawing of Flaxman, as well as in various other plates of architectural and mechanical subjects, by which this work is illustrated and adorned, and which consist almost entirely of etching.

With the view of etching subjects of this kind with superior accuracy and facility, Mr. Lowry, about twenty years since, invented and began to construct several instruments or machines, which it is within the knowledge of the writer of this article have been much employed on the engravings which are spoken of above. The first was "for etching successive lines either equidistant, or in just graduation from being wide apart to the nearest approximation, *ad infinitum*; the compass of the instrument being commensurate with the possible demands of the art. The second, which is more recently constructed, is for striking elliptical, parabolical, and hyperbolical curves, and, in general, all those lines which geometricians call mechanical curves, from the dimensions of the point of a needle, to an extent of five feet."

Within the last seven years he has constructed other machinery for facilitating particular operations in etching, and ensuring precision in describing arches of circles of every possible radius; lines converging to points at all distances; various kinds of spiral lines, and the cogs and smaller teeth of wheel work; of the several uses and superior powers of which machinery, numerous examples may be seen in what has already appeared of this Cyclopædia.

Of these inventions it may be truly said that they combine elegance with utility, and are of high value if only considered as auxiliaries of the imitative part of this branch of engraving; but as the auxiliaries of chemical, agricultural, and mechanical science, they are of incalculable advantage. The accuracy of their operation, as far as human sense, aided by the magnifying powers of glasses, enables us to say so, is perfect; and it is not necessary here to insist on the advantages that must result to the whole cycle of science,

from mathematical accuracy. A hope may be indulged that before the completion of these volumes, Mr. Lowry may be induced to favour the public with plates, and particular descriptions of his various apparatus.

It now remains to describe the composition of the several kinds of etching-ground, which have been used by different engravers from time to time.

Of etching grounds there are three principal kinds, *viz.* common etching ground, hard ground, and soft ground.

The hard ground was formerly much used, being better accommodated to the intention of imitating the engraving with the tool; but the former has now wholly superseded the use of the other, as it gives a power of expression incompatible with the greater inflexibility of the hard varnish, which confines the lines and hatches to such a sameness and regularity as give a stiffness of manner, and coldness of effect to the work.

There are various directions for preparing the common etching-varnish, which is by far the most in use and the most worthy of being so. Le Bosse recommends the following: take of virgin wax, very white and clean, and of grains of mastic very clear and pure, each one ounce; and of calcined asphaltum, half an ounce: grind the mastic and asphaltum separately, very small, and melt the wax over the fire in an earthen pot well glazed. When the wax is thoroughly melted, and very hot, sprinkle the mastic into it gradually that it may melt, and stir the mixture that the ingredients may incorporate. Then sprinkle the asphaltum into the mixture, stirring the whole composition over the fire till the asphaltum be entirely melted: take the pot from the fire, and let the mixture cool; and pour the varnish into clean warm water, and by working it with the hand, form it into a roll of about an inch in diameter, or into small balls, which may be wrapt up in taffety and kept for use. The quantity of wax should be increased in winter, in order to temper the varnish to the existing state of the atmosphere.

The following varnish is used by many of the engravers at Paris: take of virgin wax, and asphaltum, of each one ounce; half an ounce of black pitch; and a quarter of an ounce of Burgundy pitch: the asphaltum must be pounded in a mortar, and the wax melted over a slow fire in a pot of glazed earthen-ware, and the rest of the ingredients added by little and little, stirring the mixture till the whole be well melted and incorporated. Then throw the whole mass into a vessel of clean warm water, and proceed as before.

Mr. Lowry's recipe for common etching ground is as follows:—To two ounces of asphaltum add one of Burgundy-pitch, and an ounce and a half of white virgin wax. The asphaltum must first be finely powdered, and then melted in the glazed earthen vessel over a moderate fire, before the Burgundy pitch is put in: the wax must be added last, when the whole composition must be well stirred, and then poured into warm water, to be further incorporated by means of the hands, and made up into balls for use.

The *hard* varnish, which was used by Callott and other engravers of the continent, and which was commonly called the Florence varnish, was prepared in the following manner. Take four ounces of fat oil, very clear, and made of good linseed oil, like that used by painters. Heat it in a new pot of glazed earthen ware, and afterward put to it four ounces of grains of mastic well powdered, and stir the mixture briskly till the whole be well melted together, then filter the whole through a piece of fine linen into a glass bottle with a long neck, that can be stopt very securely, and keep it for use.

In laying this varnish on the plate, it may be spread evenly with the dabber and smoked, as before directed, but after

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after it is so spread, there remains to dry or harden it over the fire, for which purpose it will be proper to prepare a charcoal fire which shall emit no sparks; it should be contained in a coal-pan or chafing-dish, somewhat larger than the plate, which should be placed over it for the space of from eight to twelve minutes, every precaution being used to prevent dust from approaching the plate. Whilst in this situation the varnish will soon begin to smoke, and when this smoking is observed to decrease, the plate must be removed from the fire, and touched at the side or on the margin with a little piece of hard wood. If the varnish be easily raised by the touch, it is yet too soft, and the plate must be again placed over the fire as before: after a short time it must again be tried with the stick, and if the stick adhere to the varnish so as to require some slight effort to draw it away, the plate must from that instant be left to cool. If on the first trial the stick adhere strongly to the varnish, water must be immediately thrown on the back of the plate, to cool it as quickly as possible, lest a longer continuance of the heat render it too hard, or burn the varnish. When the plate is cold, the artist may proceed with the tracing and etching, as before directed.

The *soft* ground or varnish is prepared simply by mixing common etching ground with animal oil, in proportion of more or less according to the existing state of the atmosphere; a much smaller portion of the oleaginous ingredient being admissible in summer than in winter. If common tallow be used for the purpose, the salt which it may contain should first be precipitated, by dropping the melted tallow into water, and afterward skimming it from the top; but Mr. Gilpin recommends veal suet, and it is probably to be preferred.

The method of using soft ground is as follows. Over a plate thinly covered with this sort of varnish, and smoked as in the case of the common etching ground, the artist cautiously spreads a sheet of very thin paper, which it is best to spread in a damp state, and to fasten with strong paste by the edges, which should be folded over for the purpose on the back of the plate: the paper will thus, when dry, be stretched tight and flat over the surface of the varnish.

All is now ready for the reception of the etching, which is performed simply by making a hatched drawing of the intended subject with a black lead pencil on this paper. Great care must be taken during the etching that nothing but the pencil touch the paper, and for this purpose such a bridge must be employed on which to rest the hand of the artist, as is before recommended. When the drawing is complete, the paper must be carefully removed from the surface of the plate, which must be surrounded with a rampart of wax, and the aquafortis applied as before directed. This is the whole of the process of etching in soft ground. As much of the varnish as it was necessary to remove, in order to admit the aquafortis to the copper, will be found to have adhered to the back of the paper on which the artist has been drawing, which, presuming the plate to be judiciously *bit-in*, will exhibit the exact archetype of the impressions which the etchings will produce.

It remains to be said of etching in soft ground, that the slipping with the graver, which it is sometimes found necessary to add in certain parts, after the plate is *bit-in*, does not incorporate so thoroughly with the sketchy looseness and chalky texture of the etching, but that a judicious eye will always discover the junction, and a delicate taste will dwell on it with the same kind of dissatisfaction that we regard a modern repair of a fine old picture that has been damaged; and further, that though it be a mode of art extremely well

calculated to imitate a painter's sketch or drawing in black-lead or chalk, it is by no means capable of producing a complete abstract of a finished picture.

There are certain local energies peculiar to every branch of engraving. He who should endeavour in mezzotinto or the chalk manner to rival the playful freedom and characteristic taste which is displayed by Vivares in his etchings of trees, would find himself as much mistaken in his aims as he who by etching through soft ground, or on *stone* for which see *ETCHING on Stone*,) should attempt to render the delicate blandishments, so as to produce a complete abstract of the full harmony, of the finished works of Correggio or Claude. On the other hand, either of these modes of etching is far more capable of producing a faithful transcript of a drawing hatched with chalk or lead-pencil, than the powers of the graver and aquafortis united on copper, and of multiplying such drawings, certainly affords the most efficient means.

It may not be superfluous to add that it is not the painter's sketches that it is most desirable to multiply, but his finished performances; we wish most to see the mercury of his active imagination amalgamated with the sterling gold of his cultivated understanding; and we justly value an art of engraving as it is capable of rendering or reproducing the pure forms into which this rich mass may be moulded.

*ETCHING on Stone.* A method of etching on calcareous substances, which may be termed a chemical art of multiplying hatched drawings, has also been recently discovered in England, or recently imported from Germany; and some very spirited sketchy etchings have been executed in this way by the president West, and Messrs Fufeli, Cofway, Barry, and some other members of the Royal Academy. Messrs. Corbould, Stubbs, and C. Heath are also among those who have successfully practised this new art.

The materials were supplied by a gentleman not now in England: the knowledge of the exact proportions of the ingredients of which they consisted, was not imparted to those who made use of them, neither is it believed to have been imparted to any one else; but the materials themselves being known, the proportions may presumptively be ascertained by a little experience.

The stone was of a species resembling that fine-grained stone of a yellowish colour, which is found in large quantities in the neighbourhood of Bath, and is called Bath stone. The etchings were of two kinds; those performed with a crayon, and those performed with pen and ink. The crayon was a mixture of white wax and lamp-black, with a small quantity of shell-lac. The ink consisted of shell-lac, borax, and water, and the stones which received the crayons were ground to a surface somewhat less smooth than those which were prepared for the reception of the ink.

The method of etching is merely *drawing* on the stone with these materials. The mystery, or secret—which any chemist would easily develop—resides in the manner of printing these drawings, and is simply as follows.

The ink is to be prepared as printer's ink is commonly prepared, namely, ground up with oil, and the paper which is to receive the impression must be damped in the usual manner. The etched stone is then to be wetted by immersion in water; when it is taken out, and while it is still wet, the ink being carefully applied on its surface, without violent friction, by means of a printer's ball (such as is used in letter-press printing) will be found to adhere only where the stone has been hatched by the artist, with the crayon or ink, the antipathy of oil to water effectually preventing it from sticking any where else. The paper is now to be placed as in letter-press printing, and a pressure, which need not be very violent,

violent, applied either by means of a roller passed over the back of the paper or otherwise: a blanket or finer woollen cloth, being interposed between the roller and paper.

**ETCHING on Glass**, is performed in the following manner: Lay a thin coat of white wax (as etching ground is laid) on the plate of glass. On this the drawing must be traced in the usual way. When the subject is etched, a border or wall of wax of a very even height must be put around: take then some flour spar powdered to about the fineness of oatmeal, and strew it *evenly* over the etching, and on this pour a mixture of equal quantities of sulphuric acid and water, till the whole is about the consistence of thick cream: a cover of metal or wood must then be laid over, and fitted close on the border of wax, to keep in the fumes of the acid, the escape of which would so weaken the liquor that it would not act on the glass, and would besides be very hurtful to the lungs.

If the subject be to be etched with care, and high finishing be required, the acid mixture must be taken off occasionally, and the plate, after being well washed and dried, must have the parts that are bit-in enough, stopped-out, as in common etchings, when the mixture must be again put on, and closed down as before; and this must be repeated till the several gradations of shade are believed to be sufficiently corroded.

Etchings on glass are printed by means of the rolling press, and it need scarcely be added that much care is requisite on the part of the printer, lest the plates of glass should split in passing through the press.

**ETEA**, or **ΕΤΙΑ**, in *Ancient Geography*, a small town of the isle of Crete.

**ETELANT**, in *Geography*, a town of Asiatic Turkey, in the Arabian Irak, situated on the Tigris; 66 miles N.N.W. of Bassora.

**ETENDUE**, *Fr.* in *Music*. See **COMPASS**.

**ETEON**, in *Ancient Geography*, a town of Greece, in Bœotia.

**ETEONOS**, a town of Greece, in Eubœa.

**ETERNAL FLOWER**, in *Botany*. See **XERANTHEMUM**.

**ETERNITY**, duration which is conceived incommensurable with time, and exclusive of beginning, progress, ending, &c. See **GOD**.

Authors are much at a loss for a proper and just definition of eternity: that of Boethius, *De Consol. Philos.* lib. v. part 6. *viz.* "Interminabilis vitæ tota simul et perfecta possessio, *i. e.* a perfect possession of a whole endless existence altogether," though retained by S. Thomas and others, is faulty in divers respects.

Censorinus, *De Die Natal.* defines eternity by infinite duration, that is, duration which has always been, and always will be. Others more fully describe it by a duration that exists altogether without any flux or succession of parts prior or posterior to each other: where the word duration, taken abstractedly, imports no more than the perseverance of a thing in its existence, the *τὸ durare* being here opposed to the *τὸ cessare, in existendo*.

But soften the word duration how you will, it is scarcely conceivable but by conceiving a quantity thereof, nor a quantity without conceiving a succession. Others, therefore, define eternity by a *perpetuum nunc*, a perpetual now; or a *nunc semper stans*, an everstanding now; but neither are these unexceptionable, the words *perpetuum* and *semper stans* importing an obscure sort of duration. See **DURATION**.

**ETERNITY**, in *Mythology*, a divinity among the Romans, who had neither temples nor altars. They represented it

under the figure of a woman, who held the sun in one hand and the moon in the other: her symbols were a phoenix, globe, and elephant.

**ETERNOZ**, in *Geography*, a town of France, in the department of Doubs, and district of Quingey;  $2\frac{1}{2}$  leagues S.E. of Quingey.

**ETESIAE**, or **ETESIAN Winds**, are such as blow at stated times of the year, from what part soever of the compass they come. They are so called from the Greek word *ετης*, year, being yearly or anniversary winds, such as our seamen call monsoons and trade-winds, which, in some parts of the world, continue constantly blowing for certain stated seasons of the year. Thus the north winds, which, during the dog-days, constantly blow upon the coasts of Egypt, and hinder all ships from sailing out of Alexandria for that season, are called etesie in Cæsar's Commentaries. In other authors, the west and east winds are called etesie, when they continue blowing for certain seasons of the year. Vide Salmast. *Exercit. in Solin.* p. 421.

Cellarius endeavours to prove that those winds are properly etesian which blow from that part of the horizon which is between the north and west about the time of the solstice. *Geog. Antiq. lib. i. cap. 8.* See **MONSOON** and **WIND**.

**ETETA**, in *Ancient Geography*, a town of Upper Mysia, according to Ptolemy; called *Ægeta* in the Itinerary of Antonine.

**ETFU**, or **ΕΤΦΟΥ**, in *Geography*, a village of Upper Egypt, situated near the Nile, above Esneh, built on the ruins of the great city of Apollo, or Apollinopolis Magna, and now governed by an Arab scheik. It possesses an ancient temple, covered with hieroglyphics, among which, says Savary, we distinguish men with falcons' heads. Its inhabitants were enemies of the crocodile. The extent, majesty, and preservation of this edifice, says Denon, who has given a view of it, "surpassed all that I had seen in Egypt, or elsewhere; it made an impression on me as vast as its own gigantic dimensions. This building is a long suite of pyramidal gates, of courts decorated with galleries, of porticoes, and of covered naves, constructed, not with common stones, but entire rocks." "The excellent preservation of this ancient edifice forms a wonderful contrast with the grey ruins of modern habitations built within its vast inclosure; a part of the population of this village is contained in huts built in the courts, and around the fragments of the temple; which, like swallows' nests in our houses, defile them without concealing or injuring their general appearance." Below Etfu, the cultivated country becomes very narrow, so that there is only a quarter of a league in breadth between the desert and the river.

**ETHAM**, in *Ancient Geography*, a town of Egypt, situated in the desert, which gave name to the lower part of the Red sea, opposite to Magdalum. It was the third station of the Israelites in their escape from Egypt.

**ETHELBERT**, in *Biography*, king of Kent, succeeded to the throne about the year 560. He began his reign with a resolution to revive the reputation of his family, which had been sinking in the scale of monarchy; with this view he made war upon the king of Wessex, by whom he was twice defeated, though he was afterwards triumphant, and acquired the complete ascendancy over Wessex and the other states, except Northumberland, and reduced them to the condition of his tributaries or dependants. In the reign of Ethelbert, Christianity was introduced into England. The king had married Bertha, daughter of the king of Paris, who being a Christian, had stipulated for the free exercise

exercise of her religion, and had carried over in her train a French bishop. So exemplary in every respect were her life and conduct, that she inspired the king and his court with a high respect for her person, and for the religion by which she appeared to be influenced. The pope, taking advantage of this circumstance, sent a mission of forty monks, at the head of whom was Augustine, to preach the gospel in the island. They landed in Kent in 597, and were well and hospitably received by Ethelbert, who assigned them habitations in the isle of Thanet. A conference was held, and the king took time to consider of the new doctrines propounded to him; and in the mean while gave them full liberty to preach to his subjects. Numbers were converted, and at length the king submitted to a public baptism, Christianity proved the means of promoting knowledge and civilization in this island; and the king, with the consent of his states, enacted a body of laws, which was the first written code promulgated by the northern conquerors. Ethelbert died in the year 616, and left his crown, after a reign of 50 years, to his son Edbald. Hume's Hist. of Eng.

**ETHELBERT**, king of England, was son of Ethelwolf, and succeeded to the government of the eastern part of the kingdom in 857, and in three years afterwards he became sole king. He died in 866, but had, in the course of his reign, shewn a considerable share of vigour in defending his dominions from the inroads of the Danes, who at that period were cruel enemies to this country, and continued to ravage one part as they were repulsed from another. Hume.

**ETHELEUM**, in *Geography*, a river of Asia, which separated between the Troade and Mysia.

**ETHELING**, or **ÆTHELING**. See **ÆTHELING**.

**ETHELRED I.**, in *Biography*, king of England, son of Ethelwolf, succeeded his brother in the year 866. The reign of this monarch was short but full of troubles. The Danes had already gained an ascendancy over the kingdom, and seemed now to threaten it with entire conquest. The enterprising Alfred united his skill to the power which his brother the king was able to call forth; they pursued the invaders from place to place, and drove them from the centre of Mercia. The Mercians, careless of their liberties, or jealous of the superiority which victory was likely to give to the monarch, refused to co-operate with him, and Ethelred was under the necessity of opposing the Danes with his West Saxons alone. With these he was generally successful, till large reinforcements were sent to support the invaders, which enabled them to make a stand against the natives. The actions fought were frequently very bloody, and in one of them Ethelred was wounded. He died in 871, leaving his crown to the immortal Alfred; of whom we have already spoken. Hume's Hist.

**ETHELRED II.** king of England, was son of Edgar, and brother to Edward the Martyr, whom he succeeded to the crown in the year 978. He was at this period a minor, and from his want of capacity and vigour in the affairs of government he was, in his riper years, characterized by the epithet of "The Unready." No man, however, stood more in need of exertion and enterprise, for the Danes, who had for several years forborne all depredations, renewed their attacks with the utmost fury; and meeting with little opposition, they became more bold, till, at length, in the year 993, under Sweyn king of Denmark, and Olave king of Norway, they made a formal invasion of the country. At first nothing seemed to oppose the rapidity of their progress: and they laid siege to London, which was valiantly and successfully defended by the citizens. A mistaken policy in behalf of the English induced them to purchase the departure of the invaders, who, in 997 and

998; returned in large bodies, laid waste the southern parts of the kingdom, and demanded a still larger bribe than they had before received. To strengthen himself by a foreign connection, Ethelred married, in 1001, Emma, sister to Richard II. duke of Normandy. In the following year a dreadful massacre took place, on the same day throughout England, of all the Danes settled in the kingdom. The English in this instance were the willing instruments in the hands of the king to execute his bloody orders. They spared neither age nor sex; even a sister of the Danish sovereign, who had married an earl, and had conformed to the Christian profession, was barbarously murdered, having already witnessed the death of her husband and infant children. Such revenge, says the historian, added nothing to the strength of the nation, but rendered its enemies more implacable. In 1003, Sweyn again invaded the island, and carried desolation all along the Western coast. On a subsequent occasion the bold invader obliged the nobles to swear allegiance to him as king of England, while Ethelred, in 1013, fled into Normandy with his family. Sweyn maintained his power only a year, when death put an end to his reign, and Ethelred was recalled by his loyal subjects. He resumed the government, but had not learned that wisdom which his misfortunes were calculated to teach; he submitted to Canute the son of Sweyn, whose valour and activity he was unable to resist. Ethelred died in 1016, after an inglorious reign of thirty-five years. Hume.

**ETHELWOLF**, king of England, succeeded his father Egbert in the year 838. Little ambitious of government, one of his first acts was to give his eldest son, Athelstan, the sovereignty over Essex, Kent, and Suffex. His whole reign was molested by the incursions of the Danes, and about the year 851 they became so formidable as to threaten the total subversion of the government. The natives were not inactive, but opposed the enemy with the utmost vigour; nevertheless they took up their winter-quarters in England, and before they returned, burnt Canterbury and London. In the midst of these dangers the king, excited by a spirit of devotion, made a pilgrimage to Rome, where he remained about a year, being accompanied by Alfred, who was afterwards king. During his absence he left his eldest son Athelstan as regent, who soon after died, and thus afforded an opportunity to his ambitious brother of seizing the reins of government with an intention of dethroning his father. To avoid the evil consequences of civil war the king, without hesitation, ceded the western part of his dominions to his son. After this, influenced, in all probability, by the intriguing monks, he summoned the estates of the whole kingdom, and solemnly conferred upon the clergy the tithes of all the produce of the lands. This act of piety, as it was denominated, was considered as the most effectual measure for resisting the Danes. Ethelwolf died in 857. Hume.

**ETHER**, in *Chemistry*, is a light, odorant, inflammable liquid, produced by the action of certain of the acids upon alcohol. The acids that have actually been employed for this purpose are the sulphuric, the nitric, the muriatic, the acetic, and the stœoric; whence originate as many species, or perhaps varieties of ether, all of which we shall describe in due order.

§ 1. *Sulphuric ether*.—The method of preparing this substance is first mentioned in the Dispensatory of Valerius Cordus, published about the year 1540; it was also known to Basil Valentine, Paracelsus, and Boyle: it had, however, attracted the notice of chemists only in a very imperfect degree, before it was described by Froben, a German, in the

Philosophical

Philosophical Transactions for 1730. Since that period the preparation and properties of sulphuric ether have been carefully investigated by many able chemists, especially Scheele, Dollfus, Macquer, Pelletier, Vauquelin and Fourcroy.

The mode of obtaining ether in the small way is as follows. Take a tubulated glass retort, of the capacity of about six quarts, lengthen its beak by an adopter, and pass the other end of the adopter into a two-neck quilled balloon receiver; fix another adopter into the opposite neck of the Balloon, and join to this a common quilled balloon receiver, placed in such a position that the quill, instead of pointing directly downwards, as in the first receiver, shall slant gently upwards; then lute all the junctures with linseed meal or common paste, except that of the retort to the first adopter; fix also a 24 ounce vial to the quill of the first receiver, and loosely close the quill of the second with a cork or plug of moist paper. The lute being moderately dry and hard, withdraw the retort, and pour in through the tubulure 40 ounces by weight of rectified alcohol, and 32 ounces of the strongest sulphuric acid. Replace the retort with its contents, being careful to shake it as little as possible, and let it remain for 12 hours or more, during which the acid and alcohol will gradually act on each other, producing a considerable degree of heat. Afterwards withdraw the retort, and mix together its contents as accurately as possible, by communicating to them a gentle circular motion; this being finished, replace the retort, and carefully close by lute its junction with the adopter, and leave the whole in this state till the contents of the retort have acquired a reddish-brown colour, which will take place in a day or two. Now proceed to distillation, by placing a pot of lighted charcoal beneath the retort, observing to heat it very gradually. The first impression of the fire drives off a little highly dephlegmated alcohol, but as soon as the mixture begins to boil, the ether itself passes over and condenses on the sides of the receiver in large streaks. It is now essentially requisite to keep the receiver as cool as possible, by the application of ice or of wet cloths wrung out in cold water and frequently renewed; and if this is properly attended to, by far the greater part of the ether will be condensed in the first receiver, whence it will flow into the vial beneath; a little, however, will pass through the second adopter into the second receiver, where it must be condensed by the same means as have already been recommended. The contents of the retort are to be kept moderately boiling, till sulphurous acid gas begins to pass through the quill of the second receiver, which may be known at once by its strong suffocating odour. As soon as this is perceived, the fire is to be withdrawn, and the vial is to be detached from the receiver, and its contents poured into a ground-stoppered bottle; being then replaced as before, the process of distillation is to be re-commenced till about six or seven ounces of a coloured liquid are produced, after which the operation is to be stopped. The original mixture of sulphuric acid and alcohol is thus divided into three separate products; namely, the residue in the retort, and the products of the second and first distillations. In the retort is a black thickish matter, smelling strongly of sulphurous and acetous acids, and intensely sour to the taste. If diluted with an equal bulk of warm water and filtered through pounded glass or clean white sand, it will be separated from the carbonaceous matter with which it was loaded, and by subsequent boiling the sulphurous and acetous acids will be driven off, leaving behind sulphuric acid in a considerable degree of concentration, and applicable to a variety of useful purposes. The product of the second distillation consists of two distinct liquids, the heaviest of which is acidulous

water, and the lighter an impure ether, called *oil of wine*, which may be separated from the water by inverting the vial that contains them in warm water; a little of the ether is in consequence converted into elastic vapour, which forces out of the vial the lower and heavier fluid. The product of the first distillation is impure ether, in quantity about  $17\frac{1}{2}$  ounces. Thus from 32 ounces of sulphuric acid and 40 ounces of alcohol there are procured about  $17\frac{1}{2}$  ounces of impure ether, and three ounces of oil of wine; and the sulphuric acid that may be recovered, taking into consideration its quantity and density, amounts to about 46 per cent. of that originally employed.

Ether, when fresh distilled, is contaminated by sulphurous and acetous acids and a little coloured oil, in consequence of which it is necessary to purify it by rectification. This is generally done by adding to the ether successive portions of caustic potash or soda dissolved in water, and shaking together the two fluids in a well closed bottle, after each addition of alkali, till the sulphurous odour is totally destroyed; the contents of the bottle are then to be poured into a retort, and by the application of a gentle heat, never amounting to ebullition, the ether will pass into the receiver in a state of great purity, leaving behind a watery saline liquor covered by a thin film of brownish-yellow oil. Scheele recommends that the alkali employed in rectification should be dissolved in alcohol instead of water; the advantage of which is that no spontaneous separation of the liquors takes place, and therefore the sulphurous and acetous acids are neutralized and separated with greater certainty. Distillation at a gentle heat will readily separate the ether from the other ingredients. A still cheaper and very effectual method of rectifying ether is the following, first employed by Mr. Woulfe. "Fill three-fourths of a bottle with the impure ether, add a little water and a portion of slacked lime; agitate the bottle with violence, and keep it for some time in cold water, before taking out the cork; if the smell of the sulphurous acid be not removed, add a little more lime and agitate a second time. Decant off the ether into a receiver, and distil it off." Another very cheap and ingenious process was invented by Pelletier. It consists in adding to the impure ether a little finely pulverized black oxyd of manganese. The mixture being corked up in a bottle, is to be well shaken four or five times a day for the space of a week, at the end of which time the sulphurous acid will have been converted into sulphuric, and will have combined with the manganese, from which the ether may be poured off without the necessity of distillation.

By any of the above methods ether is rectified sufficiently for any purposes to which it is usually applied; but if the greatest possible degree of purity is required, there should be added to the rectified ether successive portions of dry pulverized muriat of lime, till it ceases to be dissolved; from this mixture, by distillation with a very gentle heat, and keeping at the same time the receiver quite cold by the application of ice, an ether may be procured, probably entirely free from alcohol and water, and of the specific gravity of 0.65.

Rectified ether exhibits the following properties. It is a transparent colourless liquor, of a peculiar and to most persons an agreeably fragrant odour, and a hot penetrating, and somewhat suffocating taste. Its usual specific gravity, according to Lavoisier, is = 0.758. It is volatilizable at a lower temperature, and more rapidly than any other liquid, a considerable proportion being lost, especially in hot weather, by merely pouring it from one vial into another; hence the vessels in which it is kept ought to be very exactly closed, and for further security are often kept inverted in cold

water.

## ETHER.

water. It boils at  $98^{\circ}$  Fahr. under the usual atmospherical pressure, and at  $20^{\circ}$  in vacuo.

Owing to the extraordinary rapidity with which ether evaporates, it possesses a very great power of refrigeration. This is made obvious to the feeling by pouring a little into the palm of the hand; it is almost instantly volatilized, and the hand becomes painfully cold. So also if some fine tow is wrapped about the bulb of a small thermometer, and the blast from a pair of double bellows is let upon it, after it has been well soaked in ether, the mercury in the thermometer will, in the space of a minute or less, be lowered to  $0^{\circ}$  Fahr. Ether, notwithstanding its ready volatility, is capable of being congealed at a low temperature. If a small matras filled with this fluid is cooled down to  $-25^{\circ}$  Fahr. by a mixture of snow and muriat of lime, the liquor becomes gradually filled with brilliant transparent crystalline laminæ, resembling benzoic acid or oxymuriat of potash; and presently, especially at a somewhat lower temperature, the whole is congealed into a white almost inodorous mass. Ether is remarkably inflammable, taking fire instantly on the near approach of an ignited body; it burns with a large white flame and a little smoke, and is resolved into water, carbonic acid, and a minute quantity of charcoal. When passed through a red-hot earthenware tube, it is entirely decomposed, and a large production of carburetted hydrogen takes place. Ether remarkably increases the bulk of any of the permanent gasses to which it was added, as was first observed by Dr. Priestley. A small quantity of this fluid being mixed with oxygen confined over mercury, exactly doubled its bulk, nor could any additional quantity occasion a further dilatation. Nearly the same effect took place with atmospheric air, azot, hydrogen, nitrous gas, and carbonic acid; but by a slight agitation in water the ether was absorbed, and the gas resumed its former dimensions without any alteration of its original properties. If oxygen gas thus diluted by ether is set fire to, it burns rapidly, but does not explode; but if one part of this mixture is added to three parts of oxygen, the application of an ignited body, or of the electric spark, causes a violent explosion, the products of which are water and  $2\frac{1}{2}$  parts of carbonic acid. Hence it appears that one part of ether requires 6.8 of oxygen for its saturation, and that the proportion of carbon to hydrogen in sulphuric ether is nearly as 5 to 1.

Water and ether appear to combine with each other in two different proportions. If equal parts of these fluids are shaken together in a graduated tube, the ether will be found to have diminished in bulk about  $\frac{2}{3}$ , and the water to have enlarged in nearly the same proportion; the lower fluid consists of water saturated with ether, and the upper fluid is ether combined with a little water. The ether in this state is said to be *washed*, and acquires in consequence some properties which pure ether does not possess; in particular, it is now capable of dissolving caoutchouc with great ease, whereas this substance is acted on by pure ether only in a very imperfect manner. Phosphorus is soluble in ether, but the solution is not luminous. When ether is boiled with phosphorus, it often deposits crystals by cooling; agitation with water produces no change in this liquid, but the addition of a little alcohol causes an immediate turbidness, whence the sophistication of ether by alcohol may be detected by the addition of a few drops of phosphorized ether. The fixed alkalies seem incapable of uniting with ether, but ammoniacal gas is absorbed by it very copiously. The same may be observed of nitrous gas; but neither of these combinations hitherto been submitted to an accurate examination. Sulphuric acid acts on ether with considerable energy, especially if assisted by a gentle heat; it is converted

into a brownish oily fluid, much heavier than ether, called oil of wine, and at a higher temperature is changed into olefiant gas. With regard to the action of oxymuriatic acid on ether, a curious experiment is related by Mr. Cruickshank. "If we fill a bottle of the capacity of three or four pints with the pure oxymuriatic acid gas, taking care to expel the water as completely as possible, and then throw into it about a drachm or half a drachm of good ether, covering its mouth immediately with a piece of light wood or paper, in a few seconds white vapour will be perceived, moving circularly in the bottle; this will soon be followed by an explosion, accompanied by flame, at the same time a very considerable quantity of carbon will be deposited, and the bottle will be found to contain carbonic acid gas." Nitric acid excites a considerable effervescence in ether, and seems to convert it into oil of wine. The essential oils are soluble in ether, and it combines with alcohol in almost all proportions.

Concerning the theory of etherification, much has been written, and many experiments have been made by able chemists, without, however, obtaining the satisfaction that could be wished. According to Macquer, ether is a substance intermediate between alcohol and oil, and alcohol approaches to the state of oil precisely in proportion as it parts with its water of composition. But though it is true that the production of water accompanies the conversion of alcohol into ether, and of ether into oil of wine, yet this is by no means the only phenomenon, so that the theory of Macquer is, at best, imperfect, since the deposition of charcoal, and the generation of acetous acid, are not at all accounted for. According to Pelletier, Chaptal, and others, the whole process of etherification consists in a transfer of oxygen from the sulphuric acid to the alcohol: the disengagement of sulphurous acid accompanies the production of ether, and therefore shews that the sulphuric acid is deoxygenated: the oxygen, thus separated, does not come over in the state of gas, and therefore must be combined with the alcohol forming ether. But in reply, it may be observed, that this mode of explanation accounts for only a few of the phenomena, and that the preparation of ether, if carefully managed, may be carried on without the disengagement of any sulphurous acid. The most elaborate enquiry into this intricate subject was undertaken by Vauquelin and Fourcroy, which we shall now proceed to detail, though it is by no means so complete and satisfactory as to preclude the necessity of further researches. The facts and observations by which this theory is supported are the following.

If one part of alcohol and two of sulphuric acid are mixed together, the temperature rises to about  $200^{\circ}$  Fahr.; the mass immediately acquires a deep brownish-red colour, which deepens into black in a few days after, and at the same time exhales a vapour manifestly ethereous.

Equal parts of concentrated sulphuric acid and rectified alcohol acquire on mixture a temperature of  $190^{\circ}$  Fahr.; bubbles of gas are extricated, the liquor becomes turbid and opalescent, and at the end of a few days acquires a deep red colour. The whole being then transferred to a distillatory pneumatic apparatus, and being heated to  $107^{\circ}$  Fahr., ebullition takes place, and ether passes over into the recipient; if the operation is carefully conducted no elastic fluid is disengaged, and the vapour, when condensed, is found to be only water and ether. When the liquor thus obtained amounts to about half of the alcohol employed, sulphurous acid begins to be manifest, and, in a short time, the production of ether ceases, and is succeeded by oil of wine, accompanied by acetous acid. The contents of the retort being kept boiling, and becoming more and more concentrated as

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the distillation proceeds, are constantly acquiring a higher temperature; when this amounts to about  $234^{\circ}$  Fahr., olefiant gas begins to come over, and continues till the oil of wine ceases to flow. At this period carbonic acid gas first makes its appearance, and water and sulphurous acid still continue to be produced, the residue in the retort being in the mean time reduced to little else than sulphuric acid thickened by charcoal.

From these facts the able chemists who observed them have concluded,

1. That the spontaneous action of alcohol and sulphuric acid, when this latter is considerably in excess, is sufficient for the formation of ether without the assistance of any extraneous heat, and that by duly proportioning the two substances, the alcohol might be wholly decomposed and made to yield all the ether of which it is capable when treated in the usual manner.

2. That the formation of ether is not owing to the affinity of the oxygen of the sulphuric acid, for the hydrogen and carbon of the alcohol, because in the preparation of ether no sulphurous acid gas is evolved till the production of ether has almost ceased. It must therefore be the entire attraction of the acid for one or more of the elements of the alcohol that determines its decomposition: now since water is formed during the whole process, and, since the attraction of sulphuric acid for this substance is very powerful, it appears likely that this is the cause that destroys the equilibrium of the affinities by which the elementary particles of alcohol are retained in combination, and induces the oxygen and hydrogen to unite and form water. Hence it might at first sight be supposed that ether differs from alcohol in containing a smaller proportion of oxygen and hydrogen. This however will not be found to be the case, when we advert to the deposition of charcoal, which, equally with the production of water, accompanies the formation of ether: now the amount of charcoal deposited is greater in proportion to that which is left, than the hydrogen of the water compared to what remains in the ether; therefore this latter fluid, though composed of the same elements as alcohol, differs from it in containing a smaller proportion of carbon compared with the hydrogen. During the progress of distillation the heat to which the materials in the retort are exposed is constantly increasing, and (the affinity of the acid and alcohol also augmenting) the acid itself is at length decomposed, sulphurous acid is generated, and the excess of oxygen deprives the alcohol of part of its hydrogen whence results the oil of wine, differing from ether in containing a larger proportion of carbon; and in confirmation of this, it may be observed, that the charcoal deposited during the production of oil of wine is not so abundant as during the generation of ether.

Hence as (according to the authors of the above hypothesis) no decomposition of the sulphuric acid takes place during the formation of ether, the agency of the acid is partly that of detaining the alcohol in a temperature more than sufficient for the volatilization of this fluid when uncombined, and partly that of assisting the caloric to decompose the alcohol in consequence of its own powerful affinity for water.

A circumstance, however, first remarked by Scheele, but which has hitherto failed to obtain the notice to which it is so well entitled, sufficiently proves that in the formation of ether the acid employed acts a much more important part than is assigned to it in the theory of Vauquelin and Fourcroy. The admirable chemist above-mentioned states that if sulphuric ether be duly rectified by agitation with caustic alkali and subsequent distillation, it occasions no precipitate with barytic salts; but if to the ether thus purified there be

added nitric acid, a copious precipitate is then produced by any of the soluble salts of barytes, indicating the presence of sulphuric acid. This fact strikingly points out that a portion of the base of the acid in a more or less deoxygenated state actually combines with the alcohol to compose ether. A like fact respecting muriatic ether is also mentioned by Scheele, namely, that though this ether, when rectified, occasions no decomposition of nitrated silver, yet the watery residue, after combustion of the ether, occasions a copious precipitate of muriated silver when mixed with the nitrat of this metal.

§ 2. *Nitrous ether.*—Although nitrous ether appears to have been known to Basil Valentine and Kunkel, yet the mode of its preparation being kept a secret, it soon ceased to be attended to by chemists, till in the year 1740 it was re-discovered by Duhamel, and afterwards was more particularly described by Navier, Sebastiani and others. It was prepared by Navier in the following manner. Put 12 ounces of rectified alcohol into a strong bottle, and add to it gradually and at intervals 8 ounces of strong nitric acid; after each portion of acid the liquors are to be well mixed by agitation, and the bottle is to be kept close corked and immersed up to its neck in ice and water; when the whole of the acid has been added, the bottle is to be well corked and further secured by a leathern cap. A stratum of ether rises by degrees to the surface of the liquor, and after five or six days the cork is to be pierced by a needle in order to let out the nitrous gas formed during the process: this gas having escaped, the cork is to be drawn, and the whole contents of the bottle being poured into a separatory funnel, the ether is thus procured unmixed with the heavier fluid on which it floats. This is, however, a very rude way of proceeding, and is attended with the utmost risk to the apparatus, the ether obtained also is in small quantity, and very impure. In order to prevent the violent and rapid action of the concentrated acid on the alcohol, which is the chief difficulty in the preparation of nitrous ether, Dr. Black proposed to interpose a thin stratum of pure water, and Fischer on the same principle made use of a little weak spirit of nitre for the same purpose. M. Dölsfus, from a careful repetition of the latter process, obtained the following result. Upon two ounces of very strong nitric acid he poured gently six drachms of the same very much diluted, and upon this three ounces of rectified alcohol. The bottle was loosely corked and suffered to stand undisturbed for three days; at this time the lower liquor appeared perfectly homogeneous with a stratum of ether floating above it. The whole being put into a retort and subjected to a gentle heat, there were obtained two ounces and a drachm of very pure ether unmixed with any acid, and the residue in the retort consisted of weak acetous acid mixed with oxalic acid, nearly the whole of the nitrous acid having been decomposed.

The last mode by which nitrous ether may be prepared, that we shall mention, and which on the whole appears to be the best, consists in mixing together alcohol and sulphuric acid, and pouring the liquor upon pulverized nitre; the sulphuric acid disengages the nitre, which immediately re-acts on the alcohol, and ether is the result. The able chemist whom we have already mentioned has shewn the excellence of this method by the following experiment. Having put into a retort four ounces of perfectly dry and pulverized nitre, he added to it a mixture consisting of two ounces of concentrated sulphuric acid, and four ounces of alcohol. The whole being submitted to distillation, there came over first six drachms of dulcified spirit of nitre, and then three ounces of a liquor from which by subsequent rectification were procured two ounces of pure ether.

Nitrous ether, when recently made, contains in loose combination a considerable quantity of nitrous gas, which in some degree modifies its properties, and renders it peculiarly liable to burst the bottles in which it is kept, especially in warm weather. This loss and trouble, however, may be avoided by rectifying the ether, which is best done in the following way. Pour into a strong vial so as to fill it two thirds, one part of ether and four parts of pump-water, and agitate it cautiously at first, frequently removing the thumb from the mouth of the vial in order to afford a free passage to the disengaged nitrous gas: when no more of this gas is given out add a quantity of dry pearlsh equal in weight to the ether, and shake the whole well together; then put the mixture into a tubulated retort and proceed to distillation, taking care that the temperature does not exceed 120° Fahr.; the ether will pass into the receiver quite pure, and may be kept for any length of time in strong well closed bottles, with no more risk of accidents than sulphuric ether is subject to.

Nitrous ether resembles sulphuric ether in most of its properties; it has, however, a dilute yellow colour, and a somewhat different odour and flavour; this appears to be owing to the presence of a little resinous matter, from which it can never be entirely freed; by repeated distillations from fresh parcels of dry white sugar, as Deyeux has observed, this impurity may, in great part, be separated, and in proportion as this takes place the ether becomes more and more analogous to that prepared by sulphuric acid.

Nitrous ether appears capable of uniting with nitrous gas in two proportions; when the ether is in excess it forms nitrous ether in the state in which it appears previous to rectification; when the nitrous gas exceeds the ether it forms a permanently elastic fluid that has obtained the name of *etherized nitrous gas*. The preparation of this differs only in the rapidity with which the nitrous acid and alcohol are made to act on each other: when the combination takes place very slowly much ether and little etherized gas are the result, but when the contrary is the case, these two products are formed in an inverse proportion. If equal parts of alcohol and strong nitrous acid are mixed together at the common atmospheric temperature, or at a higher heat in proportion as the acid is diluted, a very rapid and copious effervescence takes place, a little ether is condensed in the receiver, and a large quantity of gas passes through the conducting tube, the first portions of which are etherized nitrous gas, and the latter common nitrous gas. What remains in the retort is acetic acid with a little oxalic acid. The properties of etherized nitrous gas (according to Van Diemen and his associates, to whom we are indebted for its discovery) are the following. It has a disagreeable ethereal odour, exactly resembling that of olefiant gas when treated with oxymuriatic acid. By the application of flame it takes fire and burns with a yellowish lambent flame like alcohol; after the combustion has ceased, the vessel in which it was carried on contains a vapour of singular pungency. Water absorbs this gas, but requires a considerable time to effect this, except agitation is had recourse to, resembling, in this respect, carbonic acid. Alcohol produces the same effect as water, and takes up the gas not only more rapidly, but also in larger proportion. A solution of caustic potash also dissolves it, but with considerable difficulty, and on the addition of sulphuric or muriatic acids the etherized gas is again set at liberty unaltered in any of its properties. Ammonia, whether liquid or in the gaseous state, is incapable of contracting any union with it; the same is the case with oxygen gas at the common temperature, but a mixture of the two airs, when inflamed, produces a most violent explosion; sulphuric acid immediately decomposes this gas, by absorbing the

ether, the nitrous gas retaining its elastic state. Sulphurous acid produces the same effect, only it requires some days for this purpose. If sulphuric acid, previously diluted with an equal weight of water, is placed in contact with this gas over mercury, its action is greatly retarded, the diminution of volume in the inclosed air takes place much more slowly, and even after some days a portion of ether is retained by the nitrous gas, which in consequence acquires the property of enlarging the flame of a taper that is immersed in it, in the same manner as nitrous oxyd does. Nitrous acid, according to the degree of its concentration, absorbs either wholly or in part, the ethereous portions of the gas, and the same may be observed of muriatic acid.

Etherized nitrous gas, when passed through a red-hot tube, deposits a little oil, and by subsequent washing in lime-water is freed from some carbonic acid; the residue is nitrous gas, mixed or combined with common carburetted hydrogen, and is not acted on by the sulphuric, nitric, or muriatic acids, by caustic potash or alcohol. The addition of oxygen gas produces red vapours, the nitrous gas is converted into acid, and the gaseous residue is carburetted hydrogen.

§ 3 *Muriatic ether*.—After chemists had shewn the production of ether by means of the sulphuric and nitric acids, it was natural to attempt its preparation by the muriatic acid. But this latter, in its usual state of dilution with water, has no action on alcohol, and therefore the various modes that were first practised to obtain muriatic ether entirely failed. A few chemists were said to have succeeded by employing simple muriatic acid, but in a more concentrated and dry state than the common liquid acid; the process, however, was both difficult and doubtful, and muriatic ether can hardly be said to have been known till Rouelle discovered that it might be prepared by distilling together alcohol and the smoking liquor of Libavius, which is a concentrated muriat of tin in its highest state of oxydation. The marquis de Courtanvaux, having repeated the process of Rouelle with great care, proposes the following as the best method of making the substance in question. Mix together in a retort three parts of the fuming muriat of tin and one of alcohol; a considerable degree of heat is immediately excited, and a white suffocating vapour arises, which, however, soon disappears on agitating the mixture. As soon as an ethereous odour is perceived, let two balloon receivers be luted on, and kept as cool as possible; then by the application of a gentle heat to the retort there comes over first a little dephlegmated alcohol, which is succeeded by the ether: by an increase of temperature a few drops of coloured oil are produced, and there arises, partly in the form of a soft butter and partly in that of a dense brown liquid, a quantity of smoking muriat of tin, part of the metallic oxyd remaining in the retort as a grey powder. When the ether thus procured is mixed with pearlsh, a copious effervescence and precipitation take place, owing to the decomposition of some muriat of tin contained in the ether; after which, by distillation at a gentle heat, the ether arises in a state of great purity, amounting to half the impure product of the first distillation.

Several other of the metallic muriats have been found to be equally efficacious with the liquor of Libavius; the corrosive muriats of antimony and of arsenic, the muriats of bismuth and zinc, and the red muriat of iron, have in particular been used with success in the preparation of muriatic ether. Scheele.

Scheele, the discoverer of oxymuriatic acid, was induced to try the effect of this in the preparation of muriatic ether. For this purpose he put three ounces of alcohol into a receiver,

receiver, with which was connected a retort holding two ounces of common salt, upon which was poured an equal weight of sulphuric acid; the muriatic acid thus disengaged passed into the receiver, where it combined with the alcohol; and this, when saturated with acid, was transferred to another retort, containing three ounces of black oxyd of manganese in fine powder; the mixture instantly assumed a green colour, and presently after became so hot as to boil. When the ebullition had ceased, there was found in the receiver a liquor, from which, on mixture with water, a quantity of ether immediately separated. The same method is recommended by Van Mons, except that he employs only one fourth of the manganese used by Scheele, and performs the second distillation in a Woulfe's apparatus, the bottles of which contain a solution of caustic potash, by which the acid is prevented from re-acting on the ether.

Another mode of applying oxymuriatic acid to the preparation of ether, first practised by Scheele, is mentioned by Pelletier, and deserves to be repeated, as being perhaps the most expeditious and economical of any. He introduced into a large tubulated retort a mixture of eight ounces of manganese, and 16 ounces of decrepitated common salt, upon which he poured a mixture of 12 ounces of sulphuric acid, and eight ounces of alcohol. From this mass ten ounces were drawn off by distillation at a gentle heat, which, by subsequent rectification, yielded four ounces of ether.

It deserves to be remarked, that the ether prepared by oxymuriatic acid generally deposits, during its rectification with potash, a considerable quantity of a clear aromatic and bitter oil, which sinks in drops to the bottom of the vessel; the ether also, according to Dollfus, at least before rectification, is completely miscible with water when shaken with it for some time. The preparation of ether, by means of simple muriatic acid, is not easy, and was readily supposed to be impossible by some of the leaders of the modern school of French chemists, because it contradicted one of their early theories on the process of etherification; yet Beaumé, a chemist of great experience and unquestioned veracity, had affirmed, that he had obtained a small quantity of ether, by mixing together alcohol and muriatic acid, both of them in the state of vapour. The practicability of this method appears also to be established beyond doubt by the following formula of M. Basse. Keep a quantity of common salt in fusion for about an hour, in order to drive off all the water of crystallization, then pulverize it, and put 40 parts into a tubulated retort, connected with a Woulfe's apparatus, in the first bottle of which are to be poured 20 parts of most highly rectified alcohol; then add to the salt in the retort 20 parts of the strongest sulphuric acid, and proceed to distillation by a gentle heat, keeping the bottle holding the alcohol as cool as possible. When the alcohol is saturated with acid, transfer it to a retort, and distil over about one half of it; agitate this portion with an alkaline ley, and the ether will presently separate and float on the surface, whence it may be obtained by decantation or distillation. The quantity of ether from the above materials amounts to about five parts.

Muriatic ether has a striking resemblance to that prepared by sulphuric acid; its specific gravity, however, is greater, amounting, according to Hermbstadt, to 0.84; its taste also has a peculiar astringency like alum, and when burning it exhales a strong acid odour, somewhat resembling that of sulphurous acid.

§ 4. *Fluoric ether.*—All that we know of this substance is derived from the discoveries of Scheele. He first impregnated rectified alcohol with fluoric acid gas, by distilling

pulverized fluor spar with sulphuric acid, and placing alcohol in the receiver; the smoking spirit thus obtained was distilled with a gentle heat, but no sign of ether made its appearance. Another portion of the acidulated spirit was then mixed with black oxyd of manganese, and by subsequent distillation an ethereous fluid came over, from which, by subsequent rectification, a little ether was obtained of a very agreeable odour, resembling nitrous ether.

§ 5. *Acetic ether.*—Acetic ether was first discovered by the Count de Lauraguais; the method of its preparation was by distilling together equal parts of alcohol and acetic acid. Scheele, Pörner, Bergman, and other chemists, repeated this process ineffectually, and hence were induced to suspect some error. In consequence of these doubts, Pelletier entered into a careful examination of the subject, and has both shewn the reason of the failure of Scheele, and has given the proper method by which to succeed. He distilled together equal parts of alcohol and acetic acid, and drew off a little more than half; this liquor was acidulous, and had an ethereal odour, but no true ether could be made to separate. He then mixed together 12 ounces of strong radical vinegar, and the same quantity of alcohol, and distilled over one half of it at a boiling temperature; this product he poured back into the retort and recommenced the distillation; the produce of this and of a third distillation were in like manner recobated, and having distilled the whole again for the fourth time, he finally obtained 12 ounces of an ethereous fluid; with this he mixed a quantity of carbonated potash, sufficient to saturate the acid which it contained, and then submitted it to gentle distillation. The first six ounces that came over were pure acetous ether, the next four ounces also contained ether, but not so pure as the former. It is remarkable that during the cobinations a considerable absorption of air took place.

Scheele obtained acetous ether in a much more compendious manner, by mixing together acetat of potash, or of lead, or of copper, with alcohol, and then adding as much sulphuric acid as was requisite to decompose the acetous salt, and distilling the mixture at a low heat. The produce being shaken with water, the ether rises to the surface and may be poured off. From 16 parts acetat of lead, six parts strong sulphuric acid, and nine parts of water, Bucholz obtained six parts rectified ether.

Acetic ether always retains the odour of the acid by which it is formed; it is not so volatile as the ethers procured by the mineral acids; it burns with a lambent blue flame, like alcohol; it is soluble in a little more than twice its bulk of water, and is decomposable into acetous acid by repeated distillations at a very gentle heat.

Various other acids have been distilled with alcohol for the purpose of procuring ether, but with little or no success. Oxalic acid, with an equal weight of alcohol, yielded Bergman a watery somewhat etherized alcohol. Benzoic acid and alcohol, according to Scheele, afford no ether, but when a little common muriatic acid is added to the mixture, an ethereous liquor comes over, of which part floats on water and part sinks in the same fluid. The ether, or the lighter portion, has the odour of benzoic acid, burns with a clear flame and smoke, and is about equal in volatility to acetic ether. The phosphoric, boracic, tartarous, citric and fuccinic acids, were found by the same able chemist to be incapable of producing ether, either by their own action on alcohol, or when mixed with oxyd of manganese or muriatic acid.

ETHER, in *Ancient Geography*, a town of Palestine, in the tribe of Juda, which afterwards was assigned to the tribe of Simeon.

**ETHEREAL OIL.** See *OIL, volatile or essential.*

**ETHEREGE, GEORGE,** in *Biography*, chiefly known as a writer of comedy, was born in the vicinity of London about the year 1636. Little is known of his early years, but it is supposed he was educated at Cambridge; spent some time in foreign travel, and afterwards entered himself at one of the inns of court. His talents were but ill adapted to the laborious profession of the law; he was fond of gay and polite company, and became a writer for the stage. In 1664, his first comedy, entitled "The Comical Revenge, or Love in a Tub," was presented to the town, and well received. The author was immediately enrolled among the wits of the age. His next piece is thought to have been entitled to more praise for wit than for morality. It is entitled "She would if she could;" its licentious tendency was justly reprobated by the "Spectator," who says he knew of but one author who had professedly written a play upon the desire of multiplying our species, and that is the polite sir George Etherege in the play of "She would if she could:" "Other poets," he adds, "have here and there given an intimation, that there is this design under all the disguises and affectations which a lady may put on, but no author except this has made sure work of it, and put the imaginations of his audience upon this one purpose, from the beginning to the end of the comedy." His next piece was not produced till the year 1676; it was entitled "The man of the mode, or sir Fopling Flutter," and dedicated to the second duchess of York, Mary of Modena. It was very popular, and regarded as a true model of polite comedy; one of its principal characters was said to be a representative of the earl of Rochester, the finished fine gentleman and man of pleasure. Etherege lived a dissipated life, and in a few years injured his fortune and constitution. With a view of maintaining his rank in society, he paid his addresses to a lady of considerable fortune, who refused to marry him, unless he could procure the honour of knighthood. This he readily obtained, and upon the accession of James II. he was sent out envoy to Ratibon, where he resided some time, and from whence he wrote letters which are favourable specimens of his talent for easy pleasantry. He died soon after the revolution, but the account of the time and manner of his death has been differently related. By some he is supposed to have died in his native country soon after his return from France, whither he had been on public business, and by others it is said, that it happened at Ratibon by a fall down stairs. Besides the comedies already mentioned, Etherege was author of many smaller poems. His letters to the duke of Buckingham are in the *Biographia Britannica*, to which the reader is referred.

**ETHERINGTON'S BAY,** in *Geography*, a bay on the north-west coast of the island of St. Vincent; a little to the north of Chateau Belair bay.

**ETHESIUS LAPIS,** a name given by some authors to the chrysolite.

**ETHICAL GOOD, ETHICAL possible.** See the respective articles.

**ETHICS, Ethik,** the doctrine of manners, or the science of moral philosophy. See *PHILOSOPHY* and *MORALITY*.

The word is formed of *ethos, mores, manners*, because the scope or object thereof is to form the manners.

Gale makes ethics only the first part or branch of moral philosophy, *viz.* that which regards private persons, or in a private capacity.

By manners or morals is here meant a way, or manner, of living confirmed by custom or habit, or certain habitudes of doing, or actions which are often repeated, which, if

they be according to right reason, the morals or manners are said to be good, otherwise, evil and vicious.

Hence the object of ethics is the exercise of right-reason in all our affairs, actions, and relations; or it is a man himself considered as dirigible, and to be conducted according to reason: and the end of ethics is to make him good and happy: so that if a man conducted himself according to right reason in all the circumstances of his actions, affairs, and relations, he would arrive at the highest pitch of moral perfection and beatitude.

Whence ethics may be defined a right manner of thinking in order to attain to human felicity, or a science where-by man is directed to conduct his will, and the actions thereof, so as to live well and happily. See *WILL*.

The principal, nay, the only topics thereof, are happiness and manners, whence arise two parts or branches of ethics; the first on moral happiness, considered as the end; and the second on moral virtues or good manners, as the means to arrive at that end.

**ETHICOPROSCOPTÆ,** formed of *ethos, manners*, and *proscopos, offendo, I offend*, in *Antiquity*, the name of a sect. Damascenus, in his *Treatise of Heresies*, tells us, that the denomination of Ethicoproscoptæ was given to such as erred in matters of morality and things relating to practice that were to be done or to be avoided, &c. who blamed things laudable and good in themselves, or recommended or practised things evil. On this footing the Ethicoproscoptæ, though a numerous body, were no particular sect.

**ETHIOPIA,** in *Ancient Geography*, was a name given to several countries, both of Asia and Africa, whose inhabitants were either perfectly black or of a swarthy complexion; but *Ethiopia*, in a more restricted application of the term, or *Ethiopia propria*, was limited on the north by Egypt, extending to the lesser cataract and the island Elephantina; on the west by Libya interior; on the east by the Red sea; and on the south by a part of Africa unknown to the ancients, but probably comprehending that space which includes the modern kingdoms of Girgiro, Alaba, Machida, and part of Adel or Zeila. Proper Ethiopia, however, seems to have varied in extent at different periods; but for several ages it seems to have been the tract which at this day comprehends the kingdoms of Dongola, Sennaar, and Abassia, with part of Adel or Zeila; and consequently to have taken up 17 degrees of longitude, and to have reached from the tropic of Cancer to within six degrees of the line. Some geographers have restricted it to the tract of country that lies between Egypt and Abyssinia, about 600 miles in length, and 500 in breadth, which was called by the Arabian geographers Nubia.

The proper Ethiopia was anciently distinguished by a variety of appellations. Sometimes it was called India; sometimes Cephonia; and most usually Abasene, in sound and signification approaching very near to the modern Habash, Habesh, or Abassia. We also find Chaldæa, Assyria, and even Persia denominated Ethiopia by some authors of reputation; and it must be allowed, that the ancients called all those countries, extending themselves beyond each side of the Red sea, indiscriminately India or Ethiopia.

According to the Jews, the LXX, the Vulgate, and other versions, Cush, when applied in scripture to a country, is always to be understood of the proper Ethiopia. This opinion is supported by Philo, Josephus, Eupolemus in Eusebius, Eustathius, the author of the Alexandrian Chronicle, and the concurrent testimony of the Greek and Latin fathers. See *CUSH*.

Ethiopia did not abound in cities and towns of any considerable

## ETHIOPIA.

siderable note. *Auxume*, *Auxumis*, or *Axome*, reckoned the metropolis of Ethiopia, was undoubtedly the same city as the modern *Axuma*, or *Axum*. This country was extremely mountainous, and therefore the climate in different parts of it was very various. (See *ABYSSINIA*.) The days and nights, as Ethiopia lay betwixt the tropic of Cancer and the line, were for the most part nearly equal. The winds that blew on the mountains were, generally speaking, salubrious and pleasant; but the atmosphere over the plains stagnated and became unwholesome. The soil in those parts that admitted of cultivation was extremely fertile, and produced vast quantities of grain, pulse, and fruit. It abounded with metals, particularly gold, minerals, vegetables, and a great variety of animals. (See *ABYSSINIA*.) The most famous river that waters this country is the Nile. (See *NILE*.) The chief ports and emporia of ancient Ethiopia were those of *Adulis*, *Mondus*, *Opere*, *Mosylon*, and the principal city of the *Aualitæ*, seated upon the Red sea. The Arabs imported from their country into these ports fruit, corn, wine, and cloaths; and exported from thence to *Ocelis* and *Mufa*, opposite harbours in Arabia, spices, cassia, perfumes, ivory, myrrh, and several other commodities. The most noted islands pertaining to Ethiopia were *Meroe*, the *Sporades* of *Agatharcides*, *Altratae*, *Ara Palladis*, *Gythitis*, *Myronis*, *Daphnine*, *Magi*, *Acanthine*, *Iſis*, *Mondus*, and *Menuthias*.

According to *Pliny*, Ethiopia was anciently divided into 45 kingdoms, of which the most powerful and flourishing was *Meroe*; but he does not inform us, whether they were independent of each other, or under one supreme head. There is reason to believe, however, that the kings of Ethiopia always ruled with an uncontrollable sway. If we admit the Ethiopian tradition, that a long succession of princes, descended from *Solomon*, reigned in this country, it can scarcely be denied, that their authority was unlimited, as that of the Hebrew monarch knew no bounds. It appears from *Strabo* and *Pliny*, that some Ethiopic nations were governed always by queens, whose common name was *Candace*, as that of the Egyptian kings was *Pharaoh*, and *Ptolemy*. From *Diodorus Siculus* we learn, that a great part of Ethiopia was composed of several elective monarchies, the heads of which were chosen out of their priests; and that all these princes made the laws of their respective kingdoms the basis of their government. According to *Diodorus Siculus* the laws of Ethiopia agreed in substance with those of Egypt; which the Ethiopians accounted for by the assertion, that Egypt was first peopled by colonies that migrated out of their country. *Herodotus*, however, represents the Ethiopians as having been civilized by the Egyptians, and as having learned the customs and manners of that people at so late a period as the reign of *Psammitichus I.* *Jupiter Ammon*, according to the Greek and Latin authors, appears to have been the principal object of religious worship in Ethiopia; though the natives paid likewise divine honours to *Iſis*, *Pan*, *Hercules*, *Æsculapius*, and others, whom they considered as the greatest benefactors to mankind; and if these authors may be credited, their religion differed not much from that of the Egyptians. *Diodorus Siculus* tells us, that the Ethiopians valued themselves upon their being the first nation that had a religious establishment; and for this reason they believed, that their sacrifices were more acceptable to the gods than those offered by any other people. He assures us, however, that some of them were atheists, who looked upon the sun, on account of his scorching rays, as their implacable enemy. If a tradition of the modern *Abassines* could be relied on, the Ethiopians, or at least a considerable part of them,

adhered zealously to the law of *Moses* from the time of *Solomon* till their conversion to Christianity. According to this tradition, the queen of *Sheba*, whom our Saviour calls the queen of the south, and who ruled over a powerful nation of Ethiopia, had a son by *Solomon* named *Menileek*, who was educated at that prince's court, and instructed, under the care of his father, in the law of God. Being afterwards anointed king of Ethiopia, and sent home to take possession of his kingdom, at the desire of several eminent Israelites and doctors of the law that attended him, he introduced his father's religion, which continued among his subjects and their posterity till the time of *St. Athanasius*. See *ABYSSINIA*.

Ethiopia, in ancient times, was a country of vast extent, inhabited by different nations; and, therefore, it is natural to suppose, that a considerable variety of languages, or at least of dialects, must have prevailed in it. The most ancient of these was that called the Ethiopic, into which the scripture was formerly translated, and in which all the books of the *Abassines*, both sacred and profane, are written. According to some authors, this language nearly resembles the *Chaldee*; but, according to *Ludolfus*, who spent 60 years in the study of it, it bears as great an affinity to the *Hebrew* and *Syriac*, and approaches nearer still to the *Arabic*, from which it appears to be immediately derived. *Ludolfus* asserts, that a competent knowledge of the *Hebrew*, or any other of the oriental tongues, will enable a student soon to make a very rapid progress in the Ethiopic. The purest dialect of this tongue was that used in the kingdom of *Tigré*, where *Axuma* and the old Ethiopian kings resided. Upon the failure of the *Zagæan* line, a *Sewan* prince ascended the throne, upon which the *Amharic* dialect was introduced at court, and gradually diffused over the whole empire. (See *ABYSSINIA*.) From comparing the ancient Ethiopic alphabet, as given by the learned *Job Ludolfus*, in his "History of Ethiopia," with the old oriental alphabets, it seems not improbable, that some of them were derived from the old *Affyrian*, *Phœnician*, *Samaritan*, and *Syriac* characters. The number of letters likewise in this alphabet, and the names of several of them, tend to establish the same supposition; though *Ludolfus* believes these characters to have been invented by the *Axumites* or *Ethiopians* themselves, and to be much older than even the *Cufic* character of the *Arabs*. The Ethiopians both write and read from the left hand to the right, contrary to the custom of the orientals: a circumstance which indicates that their alphabet was not entirely of the same extraction with that of the *Arabs*.

The Ethiopians agreed in several points with the *Egyptians*, though they had many customs peculiar to themselves, some of which were very singular and uncommon. From this mutual agreement in most of their laws, their splendid funerals, the dedication of their princes, the several colleges of priests, circumcision, and most of their sacred and civil institutions, it is highly probable that the same arts, sciences, and learning, as well as religion, prevailed in both nations.

The Ethiopians were naturally bold and intrepid, but violent in their temper. They likewise surpassed the people of most other nations in beauty and size, to which a proportionable degree of strength was generally annexed. According to various authors, the proper ancient Ethiopians were, in general, perfectly black, as we find their posterity at this day, though those of some particular cantons were white, called by *Pliny* white Ethiopians. Their women were strong and lusty, and brought forth their children with little pain. From the testimony of *Herodotus*, compared with the relations of some modern authors, it is not

unlikely, that they died of old age, a few only excepted, who fell by the sword, or were devoured by wild beasts, as Sallust has observed of the ancient Africans. *Anc. Un. Hist.* vol. xvi. See **ABYSSINIA** and **CUSH**.

**ETHIOPIA**, in *Modern Geography*, is a denomination including the countries of Nubia, Abyssinia, Abesh or Abex, and Anian, which are bounded by Egypt and the desert of Barca on the north; by the Red sea and the eastern ocean on the east; by Zanguebar and Caffraria on the south; and by Guinea, Nigritia, and Zaara, on the west. Nevertheless, all the countries still, according to the ancient division, that lie almost in a straight line from Egypt to the Cape of Good Hope, may be comprehended under the general name of Ethiopia. Ethiopia is divided into Upper and Lower, the former including Nubia and Abyssinia; and the latter comprehending all the kingdoms south of the equinoctial line, as Congo, Lower Guinea, Caffraria, Monomotapa, &c. which see respectively.

**ETHIOPIC VERSION.** See **BIBLE**, *Ethiopic*.

**ETHIOPIC Year.** See **YEAR**.

**ETHLEC**, in *Ancient Geography*, a town of Upper Mæsia, according to Antonine's Itinerary.

**ETHMOID**, or **ETHMOIDAL**, in *Anatomy*, a name given to one of the bones of the head. See **CRANIUM**.

**ETHNARCHA**, **ETHNARCH**, formed of *ethos*, nation, and *αρχη*, command, a governor and ruler of a nation.

There are some medals of Herod I. surnamed the *Great*, on one side whereof is found *Ἡρῶδου*, and on the other *Ἐθναρχου*, q. d. *Herod the Ethnarch*. After the battle of Philippi, we read that Antony, passing over into Syria, constituted Herod and Phafael his brother tetrarchs, and in that quality committed to them the administration of the affairs of Judea. (*Jos. Ant. lib. xiv. cap. 23.*) Herod therefore had the government of the province before ever the Parthians entered Syria, or before Antigonus's invasion, which did not happen till six or seven years after Herod was commander in Galilee. (*Jos. lib. xiv. cap. 24, 25.*) Consequently Herod was then truly ethnarch, he can be no otherwise denominated; so that it must have been in that space of time that the medals were struck, which only gave him this title: which medals are a confirmation of what we read in history of the government which that prince was intrusted with before he was raised to the royalty.

Josephus gives Herod the appellation of tetrarch in lieu of that of ethnarch; but the two terms come so near to each other, that it is easy to confound them together.

Though Herod the Great left by will to Archelaus all Judea, Samaria, and Idumea, yet Josephus tells us he was then only called ethnarch.

**ETHNOPHRONES**, in *Antiquity*, a sect of heretics in the seventh century, who made a profession of Christianity, but joined thereto all the ceremonies and follies of paganism, as judicial astrology, fortileges, auguries, and other divinations.

They derive their denomination from *ethos*, nation, and *φρον*, thought, sentiment. q. d. *paganizers*, or persons whose thoughts or sentiments were still heathen or gentile.

They practised all the expiations of the gentiles, celebrated all their feasts, and observed all their days, months, times, and seasons. See *Damascenus*, *Hæres. N<sup>o</sup> 94.*

**ETHOLOGUS**, among the *Ancients*, a mimic, or actor, who could represent all the various habits and dispositions of the mind.

**ETHOPEIA**, or **ETHOPEA**, in *Rhetoric*, called also *Ethology*, a draught or description, expressing the manners, passions, genius, tempers, aims, &c. of another person.

The word is of Greek original, being formed of *ethos*, *mos*, *consuetudo*, and *ποιω*, *facio*, *fungo*, *describo*. Quintilian, lib. ix. cap. 2. calls this figure *imitatio morum alienorum*; and in Greek, *μυμησις*, *imitation*. In English we denominate it a *picture* or *character*.

Such is that beautiful passage in Sallust, in his "Bellum Catilinarium," wherein he gives us a picture of Cataline: "He had an uncommon strength both of body and mind, but an ill-turned and wicked disposition. When very young, his great pleasure was in intestine broils, rapine, slaughter, and civil discord. His body was formed to undergo fasting, cold, and watching, beyond all belief. His mind was daring, deceitful, and various, and could imitate or accommodate itself to every body; he was extremely covetous of other people's goods, and profuse of his own. His lusts and desires were very high; his stock of eloquence considerable, but he had little or no discretion."

The ethopœia is divided into *profopographia* and *ethopœic*, properly so called; the former of which is a picture of the body, countenance, make, dress, gait, &c. and the latter of the mind.

**ETHULIA**, in *Botany*, a name concerning whose origin or meaning we have met with no conjecture. Linnæus its author rarely explained names of his own contrivance, nor is any thing upon this occasion mentioned in his son's *Decas Prima Plantarum*, where *Ethulia* first appeared. Could he possibly allude to the remote country whence it came, as *e*, *extra*, (beyond) *Thule*, supposed by the ancients the uttermost part of the earth? If the plant had been of American origin, such an appellation would, not inelegantly, have alluded to the famous prophecy in Seneca's *Medea*, so expressive of the discovery of the western world, and ending

———"nec fit terris  
Ultima Thule."——

It was however supposed to come from Ceylon, and is actually a native of the banks of the Nile. If the above conjecture be inadmissible, the name must depend on its harmony for protection. Linnæus might well be glad to get rid of the harsh *Sparganophorus* of Vaillant, to which he would object as composed of *Sparganium*, a generic name already established. But it is probable he did not at first observe that Vaillant's genus was his *Ethulia*, though he soon recognized it. *Linn. Gen. 413. Schreb. 545. Willd. Sp. Pl. v. 3. 1740. Mart. Mill. Dict. v. 2. Ait. Hort. Kew. v. 3. 158. Juss. 184. Gærtn. t. 164. (Sparganophorus; Vaill. Act. Paris. Ann. 1719. Gærtn. t. 165.)* Class and order, *Syngenesia Polygamia-equalis*. *Nat. Ord. Compositæ discoideæ*, *Linn. Corymbifera*, *Juss.*

*Gen. Ch.* *Common Calyx* rounded, simple, of many linear, equal, spreading-pointed scales. *Cor.* compound, discoid. Florets all fertile, numerous, uniform, tubular, funnel-shaped, with some space between them; their limbs five-cleft, erect. *Stam.* Filaments five, very short, capillary; anthers united into a cylindrical tube. *Pist.* Germen angular; style thread-shaped, the length of the stamens; stigmas two, recurved. *Peric.* none, except the permanent calyx. *Seeds* solitary, truncated, top-shaped, five-sided, five-furrowed; crown none, except a prominent margin. *Recept.* naked, convex, dotted with minute excavations.

*Eff. Ch.* *Receptacle* naked. *Seed-down* none. Florets tubular, five-cleft, numerous. Scales of the calyx pointed.

This is but a vague and confused genus, depending properly on the three following species only.

1. *E. conyzoides*. *Linn. Sp. Pl. 1171. L. fil. Dec. Pl. Rar. 1. t. 1.* "Flowers panicled."—Seeds of this were sent.

sent by Professor David Van Royen to Linnæus, who raised them in his stove at Upsal, and the plant proving new, was described and figured by his son, in a work of which only two fasciculi ever appeared. Linnæus supposed it a native of Ceylon, which may possibly be correct. No new information appeared concerning it, till it was mentioned in the Hortus Kewensis as sent by Thouin, and soon afterwards Vahl discovered it to be the *Kabiria* of Forskall, so that we hence learn it to be certainly a native of the muddy banks of the Nile, where it flowers early in November. The root is annual, fibrous. Stem four feet high, alternately branched, hollow, downy, leafy. Leaves alternate, on short stalks, lanceolate, pointed, equally serrated, fragrant, downy beneath, three inches long; without stipulas. Flowers pale blue, in compound corymbose panicles about the tops of the branches, remarkable for the slender and distant tubes of their florets. The seeds form an almost globose head; each of them is crowned with a pale undivided angular border.

2. *E. Sparganophora*. Linn. Sp. Pl. 1171. (Sparganophorus Vaillantii; Gærtner, v. 2. 395. t. 165.) "Flowers in sessile axillary clusters. Calyx-scales recurved."—This we know only from the work of Vaillant, (from whom Linnæus adopted it,) and that of Gærtner; nor is its native country ascertained. The leaves are said to be like those of Golden Rod. Seeds exactly like the last in general structure, nor does there seem any doubt of their belonging to one and the same genus.

3. *E. Struchium*. Swartz. Prod. 111. (Struchium; Browne Jam. 312. t. 34. f. 2.) Flowers axillary, sessile, mostly solitary. Calyx with straight spinous points.—Gathered by Browne in Jamaica. Stem herbaceous, two or three feet high, leafy, smoothish. Leaves elliptic-lanceolate, four or five inches long, pointed, strongly serrated, thin, very slightly pubescent, on stalks an inch in length. Flowers small, axillary, sessile, either solitary or in pairs, or if more together, they have smaller leaves between them. We presume the straight spinous points of the calyx-scales will afford a certain specific difference between this and the last, whether their foliage be different or not.

In his first Mantissa, p. 110, Linnæus added three species to his genus *Ethulia*. Of these *E. tomentosa* must be entirely struck out of the system, being no other than his own *Artemisia chinensis*, and not having either the habit or characters of an *Ethulia*. The second is *E. divaricata*, Burm. Ind. 176. t. 58. f. 1. (*Chrysanthemum bengalense angustifolium pusillum, summo caule ramosum*; Pluk. Phyt. t. 21. f. 4.) Leaves linear, toothed, decurrent. Flowers solitary, stalked, terminal. Stem divaricated.—Native of rice-fields in Malabar. Koenig. Root annual. Stem three or four inches high, erect, much branched in a corymbose manner; branches leafy, quadrangular, winged, somewhat cottony. Leaves alternate, linear-lanceolate, toothed, running down into the wings of the branches. Flowers on short, simple, solitary, terminal stalks; Calyx of numerous, imbricated, sharp and somewhat spinous, spreading, purplish scales. Seeds without any crown.—We have, as Willdenow has already done, presumed to correct the description of Linnæus, and his quotation of Burmann. Linnæus moreover quotes his own *Artemisia minima*, Sp. Pl. ed. 1. n. 19, with the original specimen before him, for this *Ethulia*, but very erroneously, and his citation of Burmann is so placed as to imply that he had committed the same fault, which is not true. We cannot but observe here that Burmann in his Flora Indica has copied *E. conyzoides* and *E. Sparganophora* from Linnæus, without any real knowledge of them, so that his authority is of no avail respecting

those species. Gærtner, v. 2. 389. t. 164, retains this *E. divaricata* as the only real *Ethulia*, adding a good synonym from Plukenet (who figures the plant twice), *Chrysanthemum parvum ramosissimum, membranaceo-caule maderaspatense*; Pluk. Phyt. t. 160. f. 5. Gærtner therefore preserves the name and genus of Vaillant's *Sparganophorus*, which he contends is a very distinct genus from this plant. In the last particular he appears to be right, but the above three species unquestionably constitute what Linnæus meant by *Ethulia*, and they only agree with his generic description, so that the *divaricata* ought perhaps to be referred, notwithstanding its want of a seed-crown, to the *Grangea* of Adanson and Jussieu, as the latter suspects, or rather to make a genus by itself. (See GRANGEA.) Jussieu indeed preserves Browne's *Struchium* as a genus, but, as we presume, improperly.

One more supposed *Ethulia* remains to be noticed, named *bidentis*, Mant. 110, from its resemblance to *Bidens tripartita*. This has nothing to do with the genus under consideration, being the very identical *Flaveria capitata* of Jussieu, of which we shall speak under that name hereafter. It is a native of Chili.

With the *Ethulia uniflora* of Walter and Willdenow, we are not at all acquainted. S.

ETIENNE, in Biography, the name of a family who have been celebrated as learned printers, and are more commonly known by the epithet of Stephanus, or in English by that of the learned Stephens. The founder of the family was Henry, a printer at Paris. He is chiefly distinguished as the editor of a Pfalter, in which the compositions were divided into verses, and distinguished by figures, being the first book of Scripture in which this practice was observed. He died at Lyons, leaving behind him three sons, all eminent printers, of whom the second was,

ETIENNE, ROBERT. This young man worked at first under Simon de Colines, who had married his mother, and then set up in business for himself at Paris. He had received a very liberal education, and was well acquainted with the ancient languages, and was deeply skilled in principles of sound criticism. He carried the art of typography to a very high pitch of excellence, as a number of his books well known at present will testify. His office is said to have resembled a learned seminary, in which the Latin language was the only one allowed to be spoken by all the persons employed by him. He established an early reputation by the editions of the bible in different languages. He was the first person who introduced the division of the whole into verses; of which, we are informed, he made the necessary preparations, as he was on a journey on horseback from Paris to Lyons. These divisions have been useful as marks for reference, but in other respects they have been injurious to the work, on account of the faultiness of the divisions which not unfrequently give a wrong sense to important passages of the sacred writings. In the year 1532 he published his excellent "Thesaurus Linguæ Latinæ" in two volumes folio. This work obtained a very high reputation, and has passed through many editions: the best are said to be that printed in London in 1734, and the one printed at Basil in 1740. Both editions consist of four volumes folio. In the year 1539 the reputation of Robert attracted the attention of Francis I. who reimbursed him some of his expences in procuring manuscripts and founding new types, and gave him the honour of king's printer for Greek and Latin books. At the reformation this worthy printer, in common with many biblical critics, fell under the suspicion of heresy, and endured a long persecution excited by the doctors of the Sorbonne, who, in the year 1548 unanimously decreed that

## ETIENNE.

that his bible with a version by Leo Judæ, and notes, ought to be suppressed, and placed in the list of prohibited books. By many liberal and respectable persons Etienne was supported against the fanaticism of bigots and priests, but, at length, he thought it advisable to withdraw to Geneva, where he more openly avowed himself a friend to the reformed religion. He felt himself called on to vindicate his conduct, and published an apology, in which he retaliated upon his persecutors, and the church, by whom he had been driven into a kind of exile. At Geneva he continued to follow his profession, and published many books in favour of the Protestant cause. He was elected burgher of Geneva, and lived in habits of friendship with Beza and Calvin. He died in the year 1559, at the age of fifty-six. He has been, since his death, to the present day, the theme of admiration with the learned, and by the illustrious De Thou he was considered as better entitled to the gratitude of his country, by the perfection which he gave to the art of printing, than those warriors who had extended the boundaries of the French empire. Moreri.

ETIENNE, CHARLES, a physician of the faculty of Paris, who is considered by his biographers as an honour to the age in which he lived, in consequence of the extent and variety of his attainments. He was born about the year 1503. His father, Henry Etienne, and his brothers, Francis and Robert, were all celebrated for the ingenuity with which they cultivated the art of printing. But this family was not less unfortunate than ingenious; for, being attached to the cause of the Protestant reformation, some of them were banished from France, and others died in prison. Charles, however, during these troubles, lived and flourished at Paris, where he had for many years practised his profession, when his brother Robert became the object of persecution, and fled to Geneva. He immediately undertook the superintendance of his printing-office, which he continued to manage for several years, in the hope of effecting the restoration of his brother, practising medicine at the same time with his former distinction and success. Robert died at Geneva, however, in 1559; and Charles terminated his life unfortunately, a few years afterwards, having died in a dungeon in 1564, at the age of about sixty.

Dr. Etienne, the subject of this article, made several discoveries of minor importance in anatomy, which had escaped his predecessors, especially Galen, of whom he was a great admirer; he published some anatomical figures, the execution of which, however, was claimed by a surgeon of the name of Riviere, and generally allowed to be his; but the explanations were admitted to be Etienne's. He published a great number of works, some of which have no connection with his profession, especially the histories of Lorraine, of Flanders, and of the dukes of Milan. The works relative to medicine, besides the anatomical book just mentioned, were principally on botanical subjects. He also wrote a volume, consisting of three books, "De Nutrimētis," Paris, 1550. Eloy.

ETIENNE, HENRY, the son of Robert, was born at Paris in 1528, and became distinguished as one of the most learned men of his time. His father spared neither pains nor expence in his education, and the youth had a great facility in acquiring the Greek language. At the age of eighteen he assisted his father in collating the MSS. of Dionysius Halicarnensis. After he had performed this business he set out on his travels; staid some time in Italy, where he became well acquainted with the learned men of that country, and obtained much valuable information from the Italian libraries. From Italy he came to England, and

from thence he passed through the Low Countries in his way to Paris, whither he returned at the moment his father was driven from that city. Here he followed the united professions of printer and editor. In 1554 he published the Odes of Anacreon from the MSS. which he found in Italy. He accompanied his edition with fragments of Sappho and other lyric poets, and with an elegant metrical version. To him the learned are likewise indebted for various other Greek authors, published from MSS. which he had collected in his travels, all of which he corrected and enriched with valuable annotations. In 1572 he published his "Thesaurus Linguæ Græcæ," in four volumes folio, a capital companion to the Latin Thesaurus by his father. Scapula made an abridgement of this vast work, which greatly hindered the sale of the original, and thus defrauded the learned author of the recompence to which he had the most solid claim. This valuable man was protected by Henry IV. of France, who was so far attached to him, that he employed him in a work entitled "Sur la precellence de la Langue Francoise." He was, however, too deeply imbued with the liberal principles which real literature almost always infuses in the minds of her votaries, to escape the malice of the monks. They brought a prosecution against him for his "Preparation à l'Apologie pour Herodote." Apprised of his great danger, and well knowing the rancour of his enemies, he fled from the city and took refuge in the mountains of Auvergne. Scarcely had he left the city, when finding that he had escaped their cruel fangs, they burnt the excellent man in effigy, regretting, no doubt, that they had not his person on which to wreak their vengeance. After this Etienne resided chiefly at Geneva, though he made occasional visits to his literary friends in Germany and France. He was subject to many difficulties, and doomed to other and severe persecutions, which at length so far broke his spirits as to cause derangement, and in this state, as well as in poverty, he died at an alms-house at Lyons in 1598. Besides editing the *Poetæ Græci Principes*; *Maximus Tyrius*; *Diodorus Siculus*; *Medicæ artis Principes post Hippoc.* and *Galen*; and the *Nov. Test. Græc.*, to which he prefixed an admirable preface; he was author of some excellent pieces, besides what have been already mentioned; *viz.* *Dialogues "De bene instituendis linguæ Græcæ studiis;" "De criticis veteribus Græcis et Latinis,"* and other pieces in the French language, as well in verse as in prose. He was a man of many singularities, but truly respectable, and highly respected. He left several children, of whom his son Paul succeeded him in his Genevan printing-office, and inherited a share of his reputation. Moreri.

ETIENNE, *Saint*, in Latin *Fanum Sancti Stephani*, or *Furania*, in *Geography*, a considerable town of France, in the department of the Loire, chief place of a district of the same name, with a population of 16,259 individuals. It is situated on the river Furan, 36 miles S.W. of Lyons, and 348 miles S. by E. of Paris. N. lat. 45° 22'. The town is divided into two cantons, East and West, the former with three communes and 12,735 inhabitants, the latter with three communes and 14,669 inhabitants; the whole canton has a territorial extent of 92½ kilometres. There are at Saint Etienne and in the neighbourhood several manufactures of swords and fire arms, cutlery, and hardware of all sorts, ribbands, silks, and good bleaching grounds. The district abounds with coal-mines, and the proximity of two large rivers, the Rhône and Loire, affords great facility for the transport of the produce of the manufactures.

As chief place of a district, Saint Etienne has a sub-prefect, two courts of justice, and a register office. The district contains 9 cantons, 76 communes, and 99,261 inhabitants,

ants, on a territorial extent of  $1142\frac{1}{2}$  kilometres.—Also, a small town of France, in the department of the Maritime Alps, chief place of a canton in the district of Puget-Théniers, with a population of 1689 individuals; its canton has a territorial extent of  $212\frac{1}{2}$  kilometres, and three communes, with 3089 inhabitants.

ETIENNE *de Baigorry, Saint*, a town of France, in the department of the Lower Pyrenées, chief place of a canton in the district of Mauléon, with a population of 6187 individuals. The canton contains 10 communes and 10,939 inhabitants, on a territorial extent of 210 kilometres.

ETIENNE *de Cuines, Saint*, a small town of France, in the department of Montblanc, chief place of a canton in the district of St. Jean de Maurienne, with a population of 830 individuals. The canton has a territorial extent of  $117\frac{1}{2}$  kilometres and 6 communes, with 6496 inhabitants.

ETIENNE *de Lugdarès, Saint*, a small town of France, in the department of the Ardèche, chief place of a canton in the district of l'Argentiere, with a population of 1509 individuals. The canton has seven communes and 3439 inhabitants, on a territorial extent of 185 kilometres.

ETIENNE *de Montluc, Saint*, a town of France, in the department of the Lower Loire, chief place of a canton in the district of Savenay, with a population of 4118 individuals. The number of the inhabitants of the canton amounts to 12,453; they are dispersed in five communes, on a territorial extent of  $272\frac{1}{2}$  kilometres.

ETIENNE *de Saint Geoire, Saint*, a small town of France, in the department of the Isère, chief place of a canton in the district of St. Marcellin. It has 1546 inhabitants, and its canton comprises, on a territorial extent of  $162\frac{1}{2}$  kilometres, 13 communes, with a population of 9381 individuals.

ETIENNE *en Dévoluy, Saint*, a small town of France, in the department of the Upper Alps, chief place of a canton in the district of Cap, with only 766 inhabitants: but the canton has four communes, and a population of 2184 individuals, on a territorial extent of  $262\frac{1}{2}$  kilometres.

ETIENNE *les Orgues, Saint*, a small town of France, in the department of the Lower Alps, chief place of a canton in the district of Forcalquier, with a population of 984 individuals. The canton has a territorial extent of  $272\frac{1}{2}$  kilometres, 12 communes, and 4260 inhabitants.

ETIOLATION *of Plants, in Gardening*, the rendering them white, crisp, and tender, by excluding the action of light from them. See BLANCHING.

ETIQUETTE, a French term, primarily denoting a ticket or title affixed to a bag or bundle of papers, expressing its contents. It is also used when applied to the Spanish and some other courts, to signify a particular account of what is to be done daily in the king's household, and in the chief ceremonies relating to it. It likewise denotes those forms that regulate the decorum of conduct towards persons of various ranks and stations.

ETIVAZ *in Geography*, a small town of Switzerland, in that part of the canton of Berne which is called the Ober Land, or Upper Country, being at the foot of the highest Alps, and extending to the glaciers, or ice mountains. It is situated in the district of Gessenay, and is remarkable for its mineral springs, the water of which has a sulphureous taste.

ETLINGEN, or ETTLINGEN, a small town of Germany, in the grand duchy of Baden, situated on the river Alb, between Pfortzheim and Raftadt, at the distance of 12 miles from each. N. lat.  $48^{\circ} 55'$ .

ETMARSHAUSEN, or ETMERSHAUSEN, a small town of Germany, in the duchy of Saxe Coburg, in the district of Saltzungen, remarkable only for the following inscription, which is engraved on an old garden gate of stone,

in Latin characters: "wer weiß obs wahr ist," (who knows whether it be true.) It is become a proverbial saying in that part of Saxony, and frequently used as a polite insinuation that a person is suspected of having rather deviated from or embellished the truth; people then observe that what has been related is engraven at the garden gate at Etmarshausen. The origin, occasion, or motive of the inscription itself, has never yet been explained, and has puzzled several antiquaries of the neighbourhood.

ETMASER, a town of Arabia, in the province of Yemen; 36 miles N. of Chamir.

ETMULLER, MICHAEL, *in Biography*, an eminent physician, was born at Leipzig on the 26th of May, 1644. Possessing a taste for the sciences which his native city afforded him the most ample means of cultivating, he diligently studied under the celebrated professors of that period. He afterwards spent a considerable time in travelling through France, England, Holland, Italy, and Germany, with a view to the farther acquisition of knowledge; and on his return took the degree of doctor of medicine at Leipzig in August 1668. In the year 1676, he was appointed professor of botany in that university, and extraordinary professor of surgery and anatomy. He fulfilled those offices with great applause; and his death, which happened on the 9th of March, 1683, when he was but 39 years of age, was generally regretted by the faculty of Leipzig. The disorder, which occasioned it, was contracted while he was employed in some chemical experiments. He was a very voluminous writer, and his works were deemed sufficiently interesting at the time of their publication to be translated into most of the European languages. His medical practice and opinions were built upon the theory of Sylvius de la Boë, and the chemical sect.

ETMULLER, MICHAEL ERNEST, son of the preceding, was born at Leipzig on the 26th of August, 1673; and, after having studied at Zittau, Altemberg, and other schools of Germany, he took the degree of doctor of medicine at his native place, in 1697. He afterwards travelled to the most eminent universities of Europe, and became successively professor of anatomy, of philosophy, and of pathology at Leipzig. He had likewise been two years director of the Academia Naturæ Curiosorum, when his death occurred, on the 25th of September, 1732. He has left some dissertations of his own, but is chiefly known as the editor of the works of his father.

ETNA. See ÆTNA.

ETOBESA, or ETOBEMA, *in Ancient Geography*, a town of Spain, in Edetania, mentioned by Livy under the name of Etovissa, and situated at some distance W. of Valencia.

ETOCETUM, a place in the isle of Albion, according to the Itinerary of Antonine, which Gale fixes at Wall, near Litchfield.

ETOILE, *in Geography*, a town of France, in the department of Drôme, and district of Valence; 3 leagues N.W. of Crest.

ETOLIA. See ÆTOLIA.

ETON, *in Geography*, a large village in the hundred of Stoke, and county of Buckingham, England, is noted for its great public seminary, or college, in which many eminent statesmen, authors, military heroes, &c. have received their scholastic education. This college was originally founded by king Henry the Sixth, in the year 1440, for a provost, ten priests, four clerks, six choristers, twenty-five poor grammar-scholars, and twenty-five poor men. The first provost was Henry Sever, who was succeeded by William Waynfleet, founder of Magdalen college, Oxford. This foundation

Foundation was particularly excepted in the act for the dissolution of colleges and chantries, in the time of Edward VI. Its establishment, however, has been in some degree altered, and now consists of a provost, seven fellows, two schoolmasters, two conductors, seven clerks, seventy scholars, and ten choristers, besides inferior officers and servants. The annual election of scholars to King's college, Cambridge, founded also by Henry VI. takes place about the end of July, or the beginning of August, when twelve of the senior boys are put on the roll to succeed in this college as vacancies occur. The average number of vacancies are about nine in two years: at nineteen years of age the scholars are superannuated. Eton college also sends two scholars to Merton college, Oxford, where they are denominated post-masters. It has a few exhibitions, of twenty-one guineas each, for its superannuated scholars, towards whose assistance Mr. Chamberlayne, a late fellow, has bequeathed an estate of *Sol. per annum*, after the death of his widow. The scholars elected to King's college succeed to fellowships at three years' standing. The independent scholars at Eton, commonly called *Oppidans*, are very numerous; the average number having been for several years past from 300 to 350: when Dr. Bernard was master, under whom the school particularly flourished, the number at one time exceeded 520. Among the many distinguished persons who received their education here we find the names of bishop Fleetwood, bishop Pearson, John Hales, Dr. Stanhope, sir Robert Walpole, Horace Walpole, Oughtred the mathematician, Boyle the philosopher, Waller, Gray, West, the late earls Camden and Chatham, and the late learned Jacob Bryant; with many other eminent literary and public characters of the present day.

An ancient custom, appertaining to this college, called the "*Montem*," or "*Ad montem*," must not be passed unnoticed. This is a procession of all the scholars, &c., made every third year on Whit-Tuesday, to a tumulus, which has acquired the name of *Salt-hill*, by which also the neighbouring inns have been long known. The chief object of this ceremony is to collect money for *salt*, as the phrase is, from all persons present, even from passengers travelling the road. The collecting scholars are called *salt-bearers*, and are dressed in rich silk habits. This ceremony has been frequently honoured with the presence of the king and royal family, whose liberal contributions, added to those of the nobility and gentry educated at Eton, who purposely attend this meeting, have so far augmented the collection, that it has been known to exceed 800*l.* The sum so collected is given to the senior scholar who is going to Cambridge for his support at the university. It would perhaps be a vain endeavour to trace the origin of all the circumstances of this singular custom, particularly that of collecting money for *salt*, which has been in use for time immemorial. The procession itself seems to have been coeval with the foundation of the college, and it has been conjectured, with much probability, that it was that of the bairn or boy bishop. It is so asserted in a note among the MS. collections bequeathed to the British Museum by Mr. Cole, who was of Eton and King's college: but whence he procured this information, which, if correct, might be decisive, does not appear. The custom of hunting a ram by the Eton scholars on Saturday in the election week, supposed to have been an ancient tenure, was abolished by the late provost Dr. Cooke.

Eton college consists of two quadrangles: in the first are the school, the chapel, and lodgings for the masters and scholars. The other is occupied by the library, the provost's lodgings, and the apartments of the fellows. The

chapel, as far as relates to its external appearance, is a very handsome structure; the inside has none of that ornamental architecture so much admired in King's college chapel at Cambridge, to which this has sometimes been compared, but is quite plain, and has been much disfigured by some injudicious alterations, made in the beginning of the last century, when several of the monuments were removed, and others concealed behind the wainscot then placed at the east end. The whole length of the chapel is 175 feet, including the ante-chapel, which is 62 feet long. Among the eminent persons who are buried in this chapel, are Richard, lord Grey of Wilton, henchman to king Henry VIII.; John Longland, bishop of Lincoln, confessor to that monarch; sir Henry Saville, the learned warden of Merton, and provost of this college, who founded the Savilian professorships of astronomy and geometry at Oxford; sir Henry Wotton, an eminent ambassador and statesman, who was also provost of Eton; Francis Rowle, a distinguished writer among the puritans, and one of the lords of Cromwell's upper-house, who died while provost of Eton in 1658; Dr. Allestree, also provost, an eminent royalist, who built the new or upper school, with the cloisters beneath, at the expence of 1500*l.*, and died in 1680; and Nathaniel Ingelo, who died in 1683. The monuments of some of the above-mentioned persons are not now to be seen. Sir Henry Wotton's tomb has the following singular inscription:

"Hic jacet hujus sententiæ primus auctor—  
Disputandi pruritus fit ecclesiarum scabies"  
"Nomen alias quære."

In the ante-chapel is a statue of the founder, by Bacon, erected in 1786; the sum of 600*l.* having been bequeathed for that purpose by the Rev. Edward Betham, fellow of the college, who died in 1783: and a monument of the young earl of Waldegrave, who was drowned when at Eton school, in 1794.

The college library contains a very large and valuable collection of books, having been from time to time enriched by munificent bequests.

In 1452 the college had a charter for a market on Wednesdays, with considerable privileges; but it has been long dissolved. Two fairs were granted by the charter of 1444: one for the three days following Ash Wednesday, the other for six days next after the 13th of August. There is now only one fair, held on Ash-Wednesday. The parish church of Eton, called in ancient records *Eton-Gildables*, having been suffered to fall to decay, the inhabitants are permitted to attend divine service in the college chapel. The provost is always rector, and has archidiaconal jurisdiction within the parish. There is a chapel of ease in the village served by one of the conductors of the college; it was built for the use of the inhabitants by William Hetherington, who had been one of the fellows, and was a very liberal benefactor to the blind and to the poor of other descriptions.

Eton is situated on the northern banks of the Thames, opposite to Windsor, with which it is connected by a bridge. It is 22 miles distant from London; consists chiefly of one street; and contains 290 houses, and 2026 inhabitants. Lysons's *Magna Britannia*, vol. i. Beauties of England and Wales, vol. i.

ETORPU, one of the Kuriskoy or Kurile islands, lying 30 versts from Urup; and about 300 versts in extent. The whole island is covered with lofty mountains; one of which, at the northern extremity, emits a continual smoke, and occasionally flames. The summits of the mountains are bald, with steep cliffs and heaps of rubbish. Here are forests, consisting of the same trees with those of the island

Urup. In the southern half, near about the centre of the island, grew larch-trees, in the proximity of the sea, but slender, though further inland, in the plains of the valleys, good timber trees, fit for the purposes of building. Here are likewise black bears, and in the forests fables and foxes are met with. Of rats there is no scarcity; fish-otters haunt the streams; and the brooks abound in fish. During the storms that happen here, whales and large dolphins are thrown ashore by the sea. The sea-otter is not seen here, but sea-lions, though not of any great dimensions. The inhabitants are hairy Kurils, who dwell together in villages. They are numbered in the capitation-tax at 92 persons.

ETREPAGNY, or ESTREPAGNI, a small town of France, in the department of the Eure, chief place of a canton in the district of Les Andélys, with a population of 1201 individuals. It is situated 9 miles from les Andélys, and 9 miles W. of Gisors; its canton contains 10,442 inhabitants, dispersed in 26 communes, on a territorial extent of 140 kilometres.

ETRIGNY, a town of France, in the department of the Saone and Loire, and district of Chalons-sur-Saone;  $3\frac{1}{2}$  leagues S. of Chalons.

ETRIS, a town of Egypt; 18 miles N.W. of Cairo.

ETROEUNG, a town of France, in the department of the North, and district of Avesnes;  $1\frac{1}{4}$  league S. of Avesnes.

ETRURIA, in *Ancient Geography*, a country of Italy, separated on the west from Liguria by the river Macra; from Latium and Umbria on the east by the Tiber; on the north-east by a part of the Apennines from the country of the people called Boii and Senones; and on the south-west washed by a portion of the Mediterranean sea, called Mare Tuscum, or Tyrrheum, the Tyrrhenian sea. This country was once more extensive than the present Tuscany, as it reached as far as the Tiber. The inhabitants of Etruria, who for a long time possessed a great part of Italy, were denominated Tusci or Etrusci. (See ETRUSCI.) The principal rivers of this country were the Arnus, the Umbro, the Clanis, and the Tiber. The chief lakes were the Lacus Trasimanus, and Vulturnensis. Among the most considerable cities we may reckon Luna, Pisa, Luca, Pittozia, Florentia, Fesulae, Portus Herculis, Labronis, Voluterræ, Sena Julia, Arretium, Cortona, Perugia, Clusium, Vetularii, &c. &c.

ETRURIA, in *Geography*, a country situated between the Mediterranean, the Tiber, and the Apennines; bounded on the east by the dominions of the pope, on the north and north-east by the kingdom of Italy, on the west by the republic of Lucca, and on the south-west by the Mediterranean; about 115 miles in length, and 80 in breadth. The face of this country is beautifully varied with hills and valleys, and the soil which is rich and fertile produces abundance of corn, and excellent fruit, oranges, lemons, olives and grapes. The air is in several parts rendered insalubrious by fens and morasses; the salt-pits are rich. Manna is gathered in the marsh-lands near the sea; and the mountainous parts are rich in mines and minerals. Several medicinal springs have been discovered besides those of Pisa. Arno is the principal river; and Florence is the capital. After several revolutions, Etruria became a republic, and deriving its name from its capital, was called Florence. And in this republic the Medici family obtained by commerce the wealth and rank of princes. It was also denominated *Tuscany*, which see; and in 1569, Cosmo I. was declared duke of Tuscany by pope Pius V., which title was ratified by the emperor Maximilian II. in the year 1575, on condition of his enjoying and holding it as a fief

of the empire. By the fifth article of the quadruple alliance, made in 1718, it was stipulated that, with the consent of the Germanic body, the emperor should confer it as a fief on the king of Spain's eldest son by the second marriage, and that it should devolve to his male descendants, and on their failure to the younger brother and his heirs. In 1737 the duchy of Tuscany became annexed to the house of Austria. By the fifth article of the treaty of Luneville in 1801, the duchy of Tuscany was ceded to the duke of Parma, and erected into a kingdom, under the name of Etruria. It has since been annexed to the kingdom of Italy.

ETRUSCA TERRA, in the *Materia Medica*, a kind of bole of which there are two species, the white and the red; these are called by many authors the *terra figillata alba* & *rubra magni ducis*, as they are brought to us sealed with different impressions.

The *white Tuscan earth* is a dense and compact substance of a dull deadish white, which in drying acquires some degree of yellowness; it is of a smooth surface, and does not stain the fingers in handling. It is not easily broken, and but slightly adheres to the tongue, and freely melts into a substance like butter in the mouth. It makes a slight effervescence with acid menstruums.

The *red Tuscan earth* is a pure bole, very heavy, and of a compact texture, and of a dull brownish red colour. It is naturally of a smooth surface, breaks easily between the fingers, and does not stain the hands; it adheres strongly to the tongue, and melts freely in the mouth, and has a strong astringent taste, and leaves no sandy harshness between the teeth. It makes an effervescence with acid menstrua. This is made up of small flat cakes, and impressed with a shield bearing a ducal coronet, &c. These are the characters by which both these earths may be known from others of the same colour: they are both dug in several parts of Italy, particularly in the neighbourhood of Florence: they are kept in the shops there, and prescribed with success in fevers of many kinds, and in diarrhœas, dysenteries, and the like cases.

ETRUSCI, ETRUSCANS, in *Ancient Geography*, a people of Italy, who inhabited that part which is now called Tuscany; though it was formerly much more extensive under the name of *Etruria*. The Etruscans, in very ancient times, are supposed to have been masters of almost all Italy; for the whole region called Italia by the Latins was denominated by the more ancient Greeks Tyrrhenia, according to Dionysius Halicarnassensis (*Antiq. Rom. lib. i.*); whence it is inferred, that it was formerly subject to the Tyrrhenians, or Etruscans, and from them received that denomination. Livy and Plutarch intimate, that the seas, which partly surround Italy, *viz.* the Tyrrhenian, Ionian, and Adriatic, were anciently denominated the Etruscan sea; and that the Etruscans possessed the whole large tract extending from the Alps to the straits separating Italy from Sicily. They built twelve cities beyond the Tiber, which were afterwards the boundary of Etruria Proper on one side; and they were the founders of Nola and Capua, and possessed twelve capital cities in the tract terminated by the Po and the Alps. Virgil and Silius Italicus rank Cæsena and Mantua among the cities of Etruscan extraction; and we learn from Livy, that this ancient nation in very early times occupied the whole tract between the Alps and the Apennines. According to Pliny, Bononia, or Bologne, was anciently regarded as the principal city of Etruria; and we may observe, that many Etruscan relics and fragments of antiquity have been dug up in various provinces of the kingdom

dom of Naples, Verona, Padua, &c. as well as the duchy of Tuscany, or the Proper Etruria. The kingdom of Latium was probably a colony of the Etruscans; and the first traces of the city of Rome may possibly have been owing to that nation. However, in process of time, the Gauls made several irruptions into Etruria, and seized upon that part of it which lay between the Alps and the Apennines. The first of these irruptions happened about 600 years B.C. and the last a little before the taking of Rome by Brennus. Several colonies of Greeks made settlements in the superior part of Etruria; and from them it was denominated Magna Græcia. The Etruscans were likewise dispossessed of a large extent of territory by the Samnites and Ligurians, long before they submitted to the Romans; so that at last they found themselves confined within the limits of Etruria Propria, where for several ages they made a very considerable figure. Etruria was called by the most ancient Greeks Tyrſenia; but Polybius, and those who lived after him, denominated this country Tyrrhenia. Tyrſenia is said to be the true name, as it corresponds with that of the Lydian prince, Tyrſenus, under whose conduct, according to Herodotus, the Tyrſeni, or Tyrrheni, first made a settlement in Italy. Etruria was divided into twelve states or dynasties, each of which had its peculiar city. Each state or tribe was governed by its own prince, called in the Etruscan language "Lucumo," and received its denomination from the capital city. See ETRURIA.

The Tyrſeni, or Etruscans, were a branch of the Pelasgi, that migrated into Europe, according to Dionysius Halicarnassensis, not many ages after the dispersion. Those who marched by land as far as Lydia detached a colony under the conduct of Tyrſenus to Italy. This colony seems to have been joined by a body of Pelasgi, previously settled in some of the islands of the Archipelago. Hence some have concluded that the Lydian Pelasgi, or Etruscans, conducted by Tyrſenus into Italy, and the first Pelasgi that inhabited Greece, were the same people; but Dionysius Halicarnassensis makes the Tyrſenians and Pelasgi two different nations. The Etruscans denominated themselves Rafeni, from their leader Rafan, or Rafen; and Tyrſenus, or Tyrſen, is said to be only the name Refen, with the ferule letter T superadded. This circumstance serves to evince, not only that the Etruscan name of the people under consideration agreed with that of the Greeks, but likewise that they were both of oriental extraction. See PELASGI.

The Etruscans seem to have derived their appellation from Etruri, or Etruri, as they were anciently denominated; and that this appellation was deduced from Athuria, or Aturia, that of their parental country, may be proved from Dionysius Halicarnassensis, Strabo, and Dio. Moreover, Aturia and Assyria differ merely in dialect; the former being equivalent to the Chaldean word אַתּוּרִיָּא, and the latter to the Hebrew אֲשׁוּר, as may be evinced from Bochart (Phaleg. l. ii. c. 3.) and others. Since, therefore, nothing is more frequent than the permutation of A and E in oriental words, especially when written in Greek letters, Atura and Etura must be regarded as the same word, and as the ancient name of Etruria. More especially if we consider that Refen was a city of Aturia or Assyria, whence, probably, the leaders of the Etrurian or Etruscan colony were denominated Rafeni, or Refeni; and that, from the sacred historian, we may conclude Ashur to have been the brother of Lud, or great ancestor of the Lydians. The term Tusci, or Thufci, is of a later date, and seems to have been given to the Etruscans by the Greeks. The sacrifices, or use of frankincense, that prevailed among the Tuscans in after ages, probably suggested this appellation to that people.

As each of the twelve tribes, or cantons, called in the Tuscan language "Lucumonia," was governed by its own prince, a king presided over the whole; and whilst the lucumo assumed the administration of affairs in his own province, the king was consulted on all extraordinary occasions, and convened the general diet of the twelve nations on all pressing emergencies. This diet was held at the temple of Voltumna, which was a celebrated city of Etruria, seated on the spot which is occupied, according to Cluverius, by the present city of Viterbo; and in this temple measures were concerted for making war upon, or concluding peace with their neighbours. Although the power of each lucumo was limited, the Etruscan kings seem to have been vested with a sort of absolute authority, consonant to the first oriental form of government.

Some of the principal Tuscan laws were such as follow: 1. By the original constitution of Etruria, no single state, or lucumonia, could enter upon a war, or conclude a peace, with any neighbouring power, without the participation of the whole Etruscan body. 2. The Etruscans, by a particular law (Athen. Deipnos. l. i. p. 23.) admitted their women to all nocturnal entertainments; in which they were afterwards followed by the Romans. 3. They obliged themselves to treat all foreigners with the utmost humanity. 4. They gave all possible encouragement, as it should seem, by virtue of their constitution, to all polite arts and artificers. 5. In order to deter people from contracting larger debts than they were able to pay, the Tuscan boys, by way of ridicule, followed all insolvent debtors with an empty purse. 6. They must have had many good moral institutions, since from them the Romans received a supplement to their Twelve Tables. 7. The jura feccialia were first observed by the Etruscans. 8. The Etruscan polity, in general, seems to have been founded upon maxims of the most consummate wisdom, as may be collected from Aristotle, and Heraclides Ponticus in Athenæus's Deipnos; to which the curious reader may be referred for further information.

The religion of the Etruscans was a gross and multifarious idolatry. In common with the ancient Greeks, and Phœnicians, they worshipped the Cabiri, or Dii magni majorum gentium. They were also initiated in the Samothracian or Cabirian mysteries.

Besides the Greek and Roman deities, they had several peculiar to themselves; some of which were confined to particular towns or districts. The divine service and sacred mysteries of the old Etruscans agreed, in several points, with those of the Greeks, but in others differed from them, and these they communicated to the Romans long before that nation had any intercourse with the Greeks. The festivals, holy days, and stated times of public worship of the Romans and Etruscans, must also have agreed in several particulars, as the Romans, before they became acquainted with the Greeks, received every thing relating to religion, and even their calendar itself, from the Etruscans. The latter borrowed of the Egyptians, or rather the Phœnician shepherds expelled Egypt, their public supplications, pœnps, and solemn processions, which occurred in some of their principal festivals. The rites and ceremonies used by the haruspices, augurs, and pontifices at Rome, were derived from the Etruscans, who seem to have been the most celebrated nation in the Pagan world for skill in augury, and divination, as well as knowledge of the nature of sacrifices, to which all rites and ceremonies necessarily relate. This, however, was their character among the Romans, as Cicero and Livy have testified. Hence this branch of science was emphatically styled at Rome "Ars Etrusca," and "Disciplina Etrusca;" so that Etruria was denominated by Ar-

nobis the mother of superstition. It is observable, that neither the Etruscans nor the Romans had any magnificent temples in the earlier ages. The Etruscans had some peculiarities in their religion, which distinguished it from that of every other nation; but the ancient Egyptian and Phœnician modes of worship were the same with those, for many of the earliest ages, used in Etruria; nor can any material difference be found between the oldest oriental and Etruscan divinities. With regard to the theological notions of the Etruscans, they believed one supreme Being, whom they called Jave, or Jove; they considered him as the great governor of the universe, as the principle of life and motion. They were firmly persuaded of the immortality of the soul, and therefore believed a future state of rewards and punishments; though in later times they seem to have followed the system of Pythagoras, and consequently to have adopted the metempsychosis of that philosopher. However, the generality of the Tuscans adhered to the Sabian superstition, in common with most of the inhabitants of the East.

The Etruscan language must have been the same, or nearly so, with the Hebrew and Phœnician. The first Pelasgic settlements in Etruria could not have taken place many centuries after the deluge, and very few after the dispersion; and at that time the languages, or rather dialects of the Egyptians, Assyrians, Babylonians, Celtes, Syrians, and Arabs, must have approached extremely near to the Hebrew and Phœnician, which the learned allow to have been almost the same. In short both sacred and profane history concur in shewing the Hebrew, Phœnician, and Etruscan tongues to have been, in the earlier ages, nearly the same. This also appears from the letters and manner of writing anciently used in Etruria. The letters are almost the same with those of the earliest Greeks, brought by Cadmus out of Phœnicia. The manner of writing is purely oriental, the letters being drawn from the right hand to the left, agreeably to the practice of the eastern nations. The former point is rendered indisputable by the Eugubian tables, in conjunction with the Sigæan inscription; and the latter by merely perusing the Etruscan inscriptions. The very remote antiquity of the first colonies that settled in Etruria, as well as of the Etruscan language and alphabet, may be easily inferred from these inscriptions; for as the Pelasgic alphabet, that prevailed in Greece before the age of Deucalion, consisted of sixteen letters, the Etruscan or Pelasgic alphabet, first brought into Italy, composed only of thirteen letters, must have preceded the reign of that prince. The high, and indeed the almost incredible antiquity of the Etruscan language and alphabet, has been clearly evinced in two dissertations, printed at Oxford in the year 1746. For other particulars relating to this subject, we refer to Dempster's "Etruria regalis," Gori in his "Museum Etruscum," published at Florence in 1737; M. Bourguet's Dissertation published in 1733, and Buonarota's of Florence in 1726; and Swinton's Etruscan alphabet, published at Oxford; and for an abstract, *Anc. Un. Hist.* vol. xviii.

The Etruscans were extremely well versed in all the arts of war and peace, and from them the Romans derived those arts and sciences that paved the way to the empire of the world. In the best ages of Rome, the Romans imitated the Etruscans; nevertheless, in after-ages the Etruscans became thoroughly debauched both in principle and practice. Augury, and every kind of divination; all the principal religious institutions, temples, statues of gods and heroes, the manner of forming or building cities, fortifications, consecrations, and nuptial rites were transmitted to the Romans by the Etruscans. Every thing also that bore any relation to civil

government at Rome, such as ensigns of royalty, the distinction of nobles from plebeians, the securæ and fasces, the lictors, &c. was derived from the same source. Arms, instruments of military music, military accoutrements and decorations, trophies, triumphs, chariots, crowns, &c. and in short every thing belonging to the art of war, or military exercises, that prevailed at Rome, were brought from Etruria. This was also the case with respect to money, locks and keys, lamps, candlesticks, glasses, cups, drinking vessels, together with the laws and customs relating to banquets and entertainments. Agriculture, planting of vines, all instruments requisite in husbandry, mills, architecture, music, and a variety of musical instruments, many sorts of diversions, especially tragedies, various kinds of garments, and even the rudiments of physic, seem to have been introduced into Italy by the Etruscans. Scenical amusements, masks, pantomimes, wrestlers, the custom of anointing their bodies, the use of wool, plastic statuary, the fabulæ œscæ or Atellanæ, nuptial verses, or versus Fescenini, and the art of making earthenware, were also derived from the Etruscans. The art of constructing ships and of navigating them, the method of equipping fleets, and all kinds of naval armaments, were known to the Etruscans before the time of Romulus; and hence we may conclude, that this nation must have been a maritime power, and that it must have possessed an extensive commerce in the earlier ages of the world. The Etruscans, who were followers of Pythagoras, and who cultivated the principles of the Italian philosophy, must have cultivated the art of music and poetry, and must have been well versed in natural philosophy and astronomy. Tragedy is said to have owed its birth to this nation; or at least they first communicated it to the Romans. The first actors who appeared upon the stage of Rome were sent for from Etruria. Besides, the ancient Etruscans, valuing themselves upon being the disciples of Pythagoras, could not be strangers to geometry, nor indeed to any of the mathematical sciences. For military learning they were famous, and especially for the art of drawing up an army, and making dispositions for an engagement. Athenæus informs us, that the formation of the phalanx, and manner of fighting consequent upon it, was invented by the Etruscans, or at least borrowed from them by the Romans. To all the other branches of literature and science for which the Etruscans were distinguished, we may add that they excelled in the knowledge and composition of history.

The first person who fixed monarchical government in Etruria was Janus, supposed by some to be the Javan of scripture, or one of his posterity, and in subsequent ages deified by his subjects as a singular benefactor. The history of their succeeding kings is intermixed with much fable, and, of course, very obscure and uncertain. It appears, however, that they were a maritime power in the time of the Argonauts; and that they commanded respect as such at least a generation before the Trojan war, and made a figure at sea before the Greeks. That the Etruscans were a powerful and polished nation, when Romulus founded or rather restored Rome, appears from some approved authors. That prince could not carry the design he had formed into execution, without the assistance of the Etruscans. From them he derived all his civil and religious institutions. *Anc. Un. Hist.* vol. xviii.

ETSED, in *Geography*, a town of Hungary, 40 miles N.W. of Zatmar. N. lat. 48° 2'. E. long. 21° 51'.

ETTENHIEM, a town of Germany, in the bishopric of Strasburg; 12 miles S.S.E. of Strasburg.

ETTENSTATT, a town of Germany, in the principality of Anspach; 5 miles N.E. of Weiffenburg.

ETTERSCHAUSEN, a town of Germany, in the principality of Wurzburg; 3 miles N. of Volckach.

ETTLSTORFF, a town of the archduchy of Austria; 9 miles W. of Sonneberg.

ETTRICK, a river of Scotland, which originates in the S.W. angle of the shire of Selkirk, and runs N.E. augmented by many small streams in its progress through a pleasant valley to the Tweed, into which it falls near Sunderland-hall,  $1\frac{1}{2}$  mile below Selkirk. The banks of this river were formerly shaded with woods, whence the county obtained the name of Ettrick forest.

ETUEND, a mountain of Persia, in the province of Irak; 60 miles S.E. of Hamadan.

ETYMOLOGICON, is used for a book, containing the etymologies of many languages. See ETYMOLOGY.

ETYMOLOGY, (from the Greek *ετυμος*, true, and *λογος*, a word,) means a true or real account of words: and as this true account is obtained by tracing them to their origin, etymology hence signifies that part of grammar which teaches the derivation of words.

Etymology is an essential and useful branch of philology; but from partial views, and an inattention to the principles which it implies, it is regarded by many as the fruitless study of words, in which neither knowledge nor certainty is attained. In order to limit, as much as possible, the province of etymology, and to remove the objections which have been made against it, we shall here briefly state the laws which direct, and the considerations which give it the precision and the fixedness of a science.

1. Etymology implies a due attention to the structure of the vocal organs, or to the affinities of elementary sounds. All men have the same organs of speech, and the same letters are founded by a similar modification of those organs. Letters pronounced by the same organs, or the same parts of the mouth, approximate in sound to each other, and from this consideration become more easily corrupted and changed one for another. Thus all the vowels, whatever peculiarity in character and sound they present to a person familiar with them, have yet a closer affinity to each other than to other letters; and hence are even interchanged. The more modern art of printing, indeed, has contributed to fix the fluctuating sounds of the vowels, by uniformly presenting them to the eye under distinct characters; but still in an etymological view they are utterly to be disregarded, or to be regarded only as one capricious, ever fluctuating impulse of the voice.

The justness of these observations will immediately appear to any one who considers those words in Latin, which are evidently derived from the Greek; or those in French and in Italian, which are derived from the Latin; or those in modern English, which are borrowed from the Gothic and Saxon tongues, and are still farther diversified in the Scotch, Irish, and Welsh dialects.

While the vowels form, as it were, the ever corrupting flesh, or the ever varying complexion of language, the consonants are the sinews and bones which impart to it strength and firmness, and which alone render it a subject of philological investigation. But the consonants have a closer alliance to some than to other letters; and their affinity depends on the manner in which they are enunciated. Thus, *p, b, f, v, w, m, or φ* in Greek, are kindred letters, being produced principally by the lips, and are therefore often changed one for another, as caprice or custom shall dictate. The same observation holds in regard to the letters *s, t, d, r, l*, which being produced by the tongue, impressed in various degrees on the extremity of the upper teeth, are called *dentals*; to those which are produced by the tongue and the

roof of the mouth and the palate, such as *g, j, z, ch*, and finally to the gutturals, which, though they exist not in our tongue, form an important class of letters in most other languages. To this distribution of the consonants into *labials, dentals, palatines, and gutturals*, the scientific etymologist will pay a strict attention, and observation will soon teach him that, however perfect any alphabet may be in regard to etymology, each class is but a variation of the same letter.

2. Etymology supposes a strict attention to be paid to *analogy*, that is, to those general principles by which any language is formed in regard to its internal structure, to the distinguishing terminations of its nouns and verbs, to its general mode of combining words, and to those changes which words usually undergo after they have been imported and naturalized, as it were, from any foreign tongue. In order to discover the nativity and parentage of any term, we must, as it were, strip it of the dress with which the custom of the country has clothed it, and we can trace it to its true origin, only when we view it separated from the termination by which it is disguised: thus *μηνη*, when imported into English, appears under the form of *moon*, having dropped *n*, its peculiar termination; and when expressing that period of time which comprehends one revolution of the moon, it assumes the termination *th*, which the analogy of the language hath warranted *month*; while in Latin it exists in the shape of *men-sis*. And here it is to be observed, that the general principles of analogy, as in natural philosophy, so in etymology, are to be collected by *induction* from instances that are simple, unequivocal, and definite, and then applied to words that are not so. The propriety and justice of these remarks it will be necessary to illustrate by a few examples.

Suppose we were asked the derivation of *οινος*, wine, *ου*, or *i*, self; *αυτοσυνα*, to rule, in Greek; we should be able to ascertain this only by unfolding a general principle in the structure of that language. The oriental tongues, to which the Greek owes its origin, abound with gutturals, which by degrees softened down into an aspirate in many of those words derived from them; while in others they melted into simple vowels, or were replaced by a labial, such as *φ, f, b, v*, or *w*. Thus *קֵה*, *khee*, life, self, became *ου*; *קֵהן*, *khaan*, a king, *αυτοσυνα*, to rule, and *יֵה*, *yeen*, *οινος*. In these derivations our conviction would be complete, because it is justified by a general principle that holds in a thousand other instances.

Suppose, farther, we were asked what were the origin of the Latin *vicus*, a village; *video*, to see; *vinum*, wine; *ovis*, a sheep; or of *wheel*, *year*, *well*, *weal*, in our own tongue; we answer that the substitution of a labial for an aspirate or a guttural, or a diphthong, forms a general principle which pervades the Latin tongue in its formation from the Greek. Hence *vicus* is from *οικος*; *vinum* from *οινος*; *ovis*, from *ου*; *video* from *εδο*. With respect to our own language a similar analogy obtains, which has converted a guttural into a labial; thus *laugh* is pronounced *lass*; *enough*, *enuff*; and most of those words which begin or end with *y* and *w*, whether derived from Hebrew, Greek, or Gothic, began or ended with a guttural. On this general principle *year* may safely be said to be derived directly or indirectly from *κυρος*, a circle, and means a period or revolution of time; *wheel*, from *ωδω*, to roll; *well*, from *קֵה*, *geel*, a fountain; and *weal* from *קֵה*, *kheel*, strength, which also has given birth to the words *beal*, and *health*.

Moreover, if we were asked the origin of *sperno*, to despise, we should say that it comes from *πτερον*, the beel, for the prefixing of the letter *s* to Greek words is a principle that pervades the Latin tongue; thus the primary sense of *sperno*,

is to put the heel upon; on the same principle is *salio*, *insilio*, *insult*, taken from ἀλλομαι. The French generally drop the gutturals either in the middle or at the end of words; hence we should be justified by an invariable analogy in saying, that *eau*, *water*, is from *aqua*, and *seul* from *singulus*. The Italians generally drop the liquid *l*; agreeably to this custom of the language, *fiume* is derived from *flumen*, a *stream*, and *piano* from *planus*, a *plain*. In German most of those words which have *t* in English are used with an *s*; as *waser*, *water*; *besser*, *better*; *es*, *it*: and the corruption of *m* into *f*, or *v*, is a principle that runs through the Welsh tongue; thus, *ve*, *voer*, and *wayr*, are but the Latin words *me*, *mare*, and *major*.

3. Etymology, in order to claim its proper rank as a branch of science, requires a strict attention to the *association of ideas*, the great law which regulates the human mind. The opinions and customs of men, it is well known, greatly influence their language; and this influence is produced by the secret and unerring impulse of association; and the reason why this branch of philology has been so much abused or called in question, is, that little or no regard has been hitherto paid to its connection with that grand invariable principle which governs the human understanding. He who attempts at etymology in any language must know the philosophical, the religious, and the political notions of the people who use it; he must be acquainted even with the physical peculiarities of their country, and from an acquaintance with the laws of the human mind he should be able to trace the secret process by which those circumstances influence their speech. We will give a few examples in illustration of these remarks.

In the early ages of the world, the principal idea under which the character of *God* presented itself was that of *superior power*; and, accordingly, the feelings which it awakened in the beholder were chiefly those of *fear*. And even the Jews, who had far more rational notions of the Deity than the Gentiles, apprehended that no one could see *God* and live. Accordingly most of those names, which signify a god, are in Greek either immediately derived from a word which signifies *fear*, or both from a common origin; thus, from אֱלֹהִים, *baab*, the first principle of things, are taken θεοί, gods; and φόβος, *fear*; τερρῶς, *terror*, owes its origin to the Chaldean תֵּרַח, *Terph*, a household god. Παν, the god *Pan*, is only the Hebrew פֶּן, *pon*, *conspiration*; δαίμων is the god of *terror*, and hence δαίμων, an invisible spirit, which was an object of *fear*, and δαιμονισμῶν, the fear of the demons, religion. It was the common notion that those demons produced violent passions and disorders in the mind and body: hence came the verb δαιμονίζω, to be mad. It was thought, too, that they were the agents of *God* in presiding over men; hence εὐδαιμων, one who had a good demon for his guardian angel, and κακοδαιμων, one who had an evil one.

The introduction of evil into the creation could not be accounted for by the heathen philosophers, only by supposing the existence of two principles equal in power, and opposite in character and operation. The good principle they naturally assimilated to the *sun*, the most splendid body in nature, whilst the evil they called *darkness*; hence the saying *God is light*: אֵל, is pronounced by the Persians *tee*, but by the Arabians *dee*, or *ideio*, *light*; hence ζῆν, from the former mode of pronunciation, and *deio*; from the latter. On this principle the Chaldean אִין, *aza*, to make hot, the action of the sun, gave birth to אֵל, to worship, or reverence. The general opinion among the philosophers was that water is the first principle of things. Hence the Arabic *mao* came, in Persian, with little variation, to signify *fruit*, *wine*, and in

Greek, *μασα*, the goddess of birth, and in English the producing month, *May*. The same word in Hebrew, by assuming *t* after the analogy of feminine nouns, is מוֹת, *mot*, *death*, which means *resolution into water*; hence the Egyptian *mot*, (whence *Moses* is supposed to have been taken,) and *mud*, what is washed together by water, just as *lutum*, *clay*, is the supine of *lavo*, or *luo*, to wash.

In eastern countries, where the heat of the sun is violent and long continued, rain is deemed the greatest blessing, and all the terms expressive, in most of the Asiatic tongues, of plenty, success, and joy, are generally borrowed from the names of water; hence the Hebrew בֵּרַךְ, *berck*, to bless; in Greek is βρέχω, to rain; in Latin *precor*, to ask for blessing, *parco*, to give blessing; *spare*, and *spargo*, to shed as the dew, or scatter as seed. The same root exists in English in the form of *brook*, the effect of rain.

4. Etymology, in order to become a rational study, implies an extensive and an accurate acquaintance with languages. It is not sufficient to be acquainted with Latin to know Greek; nor to know Italian to be acquainted with Latin, nor to know English to be acquainted with the Saxon or Gothic; but to be a good etymologist in either of these, a man must comprehend them all. So manifold is the intercommunity between all languages, that no language exists derived from one and the same source. Words exist in English which exist also in most other tongues, under differences of character and termination; and they are derived not from each other, but from a common origin; and a scientific etymologist, instead of deriving them from each other, will trace them all till they meet in a few primitive terms. It would probably be wrong, or at least it would be very doubtful to say, that *hand* comes from the Latin obsolete *hendo*, to catch with the hand, or from χερς, the parent of *hendo*, but it would be right to say that these are connate, or kindred terms, sprung, if not from each other, from some common root. In Hebrew, Persian, and Arabic אֶבֶן, *capb*, is the hand. The action of this is two-fold, as it imparts, or as it receives. In the former sense it gave birth to the Saxon or Gothic *giff*, and hence *if*; in the latter to *capio*. To take in hand is to begin a thing; hence the same word exists in the form of *Capio*; and passing into Greece it produced *καπη*, a handle.

And here it is obvious to remark, that as the root, passing into different countries, produces as it were new branches; those branches will not continue long till they in their turn become the stems of more numerous and diversified shoots; and as they thus multiply by accident, the progress of knowledge, the multiplication and distinction of ideas attendant thereon, seize, as it were, these wild and promiscuous offspring, and give them the sanction of custom, the supreme arbiter of speech, thus considering as genuine, words which at first were mere corruptions. Thus in our own tongue *gust* is wind; hence *ghost*, what consists of wind, *spectre*, a *ghast*, *ghostly*, like a *spectre*, and *gas*, an aeriform fluid, so denominated from *ghost*, first by Van Helmont. Thus also in Latin, from *πνυω*, to join together, is *pango*, to fasten, *paco*, to unite in concord, *pacify*. To paint is to fasten adventitious colours on a thing; hence *pingo*, and to give to falsehood the adventitious colours of truth is *fingo*, to feign. Again, from *μενος* is *men's mind*, *force*, *essence*, *memini*, to call to mind, *mones*, to put in mind; *manus*, *force*, or that organ in which the strength of the human body chiefly consists, *manes*, the souls or departed spirits, spirit being the essence of man; and *maneo*, to exist, the soul being that which exists after the destruction of the body.

Etymology, then, to be raised above the caprice of fruitless study, and to be classed among the useful and solid branches

branches of science, must be founded on a just regard to the affinities of letters, and to the structure of the organs of speech. It supposes an acquaintance with the philosophy of the human mind; with the analogies which form and distinguish each language; with the history of mankind, philological, religious, and political. From these, its qualifications, results its utility as a department of human knowledge. Etymology, it is evident, furnishes the readiest and most effectual means to acquire the knowledge of language; and as language is but the dress of our ideas, it holds up a mirror to delineate and reflect the operations of the human mind. It helps to ascertain the positions of ancient places, to clear obscurities in the antiquities of nations and families. What is more, when confined within its proper limits, and pursued to its full extent, it will throw much light and additional evidence on the truth of the Mosaic history, respecting the origin and propagation of mankind.

EU, or Eo, in *Geography*. See Eo.

Eu, a sea-port town of France, and chief place of a canton, in the department of the Lower Seine, and district of Dieppe, seated on the Bresse, near the coast of the English channel; 15 miles N. of Dieppe. The place contains 3400 and the canton 12,810 inhabitants, on a territorial extent of 182½ kilometres; and in 27 communes.

EVA, in *Ancient Geography*, a town of the Peloponnesus, in Arcadia.—Also, a hill of the Peloponnesus, in Laconia, near Sellasia. Polybius.

EVACUANTS, in *Medicine*, are those remedies which operate by diminishing the quantity of fluids in the body. This effect may be produced either directly, by an artificial opening into the vessels or cavities containing the fluid to be evacuated; as by blood-letting, by means of the lancet, or by cupping; by tapping; &c. Or the evacuation may be accomplished indirectly, by exciting the action of the vessels, which are naturally destined to throw off redundant fluids, on the one hand; or by producing inflammation, and a consequent discharge of fluids, from parts not naturally secreting them. Evacuants acting upon the natural emunctories, as the organs of excretion have been called, are of various quality and denomination, according to the parts upon which their action is exerted: thus, some stimulate the vessels which open into the cavity of the intestines, and carry off the fluids by stool, and are called *purgatives*, *laxatives*, or *CATHARTICS*; others excite the vessels of the kidneys to increased action, and are denominated *DIURETICS*; others augment the perspiration, and are termed *DIAPHORETICS* and *sudorifics*; others again stimulate the salivary glands, and produce a great discharge of saliva, whence they are called *SIALOGOGUES*; and others excite an increased discharge of the mucus of the nostrils, and are termed *ERRHINES*. All these kinds of evacuant medicines are occasionally employed, with a view to relieve the constitution at large, or some part of the body, from an inflammatory or febrile condition; or to remove local congestions in particular organs, &c. See *BLEEDING*, *CUPPING*, and the words in capitals; under which heads the principles of the evacuation, thus variously effected, are explained.

EVACUATION, see the preceding article.

EVACUATION, in a *Military Sense*, relates to the withdrawing of troops from any fortrels or post, not besieged, but intended to be relinquished; or eventually to be dismantled. This term is sometimes erroneously used in capitulations, where it is expressed that the garrison shall evacuate within a certain number of hours. Now, as it is in almost every case, a stipulation on the part of the victors,

that they shall be put in possession of certain gates, or defences, previous to the garrison marching out; thereby securing every advantage that may have been obtained; it stands to reason, that the term evacuation is incorrectly applied. We have, indeed, but rarely instances wherein it is properly introduced; one very recent case is however very prominent; namely, the evacuation of certain fortresses in Prussia by the French troops; for, if we are correctly informed, the Prussian forces did not, in some instances, attempt to enter until their *friends* had completely withdrawn.

It is sometimes made a condition, that particular approaches, lines, or posts, shall be evacuated; there we see the term appropriately used; because such approaches, and lines especially, are not considered as permanent works; therefore are intended to be dismantled so soon as those who erected them should retire.

Where a place is to be evacuated under the express condition of all damages being paid for, it becomes the duty of the future possessors to be very correct in causing an enquiry to be made into all depredations and grievances, before the forces about to retire quit the place. Commis-sioners on both sides are necessary; in order that every matter may be adjusted at the moment, so as to obviate future disagreements. This appears to have been attended to when the Portuguese territory was evacuated by Junot; though we have strong reason to apprehend that great evasion, and many highly nefarious acts, were practised by the French on that occasion.

EUÆMIA, of *eu*, *well*, and *αμα*, *blood*, is used by Tremelius and some other writers, to denote a good and healthy state of the mass of blood.

EUÆMON, in *Ancient Geography*, a town of Greece, placed by Steph. Byz. in the territory of the Orchomenians.

EVAGRIUS, in *Biography*, patriarch or bishop of Constantinople, who succeeded Eudoxus in 370, and whose election was much resented by the emperor Valens. From this event commenced a cruel persecution against the Catholics, which did not terminate till the accession of Gratian to the throne. Evagrius probably died in exile during this period.

EVAGRIUS, bishop of Antioch, succeeded Paulinus in the year 389; in consequence of whose election, in opposition to Flavianus, the schism in the church of Antioch, that has been much lamented by the orthodox, was continued. However, by the influence of Siricius bishop of Rome, in the council of Capua, held in 390, Evagrius's election was approved. Two years afterwards Evagrius died, and the schism terminated. Evagrius was the friend and companion of St. Jerome, who represents him as a person of an active and ardent spirit, and as the author of various writings, which he had perused. None of these that deserve particular mention are now extant. Cave. Dupin.

EVAGRIUS, surnamed *Ponticus*, and by St. Jerome *Hyperborita*, on account of the situation of the place of his nativity near the Euxine sea, flourished near the close of the fourth century. Having been ordained deacon of Constantinople by St. Gregory Nazianzen, he was instructed by this bishop in biblical learning, and advanced to the office of his archdeacon. His person and manners recommended him to the favour of the ladies; and being suspected of an improper intimacy with the wife of a man of consequence, he was obliged to retire from Constantinople in the year 385, and to remove to some distant place. At Jerusalem he embraced the monastic life, and passed 15 years at a monastery amidst the deserts of Nitria in Egypt.

Whilst

Whilst he was in this situation he refused the episcopal dignity which was offered him by Theophilus bishop of Alexandria. He afterwards defended the opinions of Origen, and laid the foundation of the tenets which, in the course of a few years, were propagated by Pelagius and his followers. He lived to an advanced age, but the time of his death has not been ascertained. Sozomen speaks of him as a man, distinguished by his learning, judgment, and eloquence; and represents him as devout, humble, abstemious, and irreproachable in his manners. Some of his writings are found entire in the "Bibliotheca Patrum," and in "Cotelerius's Monum. Eccl. Græc.;" but fragments only of the greater number are dispersed in the works of Socrates and other authors. Socrates' Hist. Eccl. Cave. Dupin. Another monk of this name flourished among the ecclesiastical writers of the fifth century. Cave. Dupin.

EVAGRIUS, an ancient ecclesiastical historian, was born at Epiphania, a city of Syria in 536 or 537. From the study of rhetoric and the profession of an advocate, in which he acquired considerable reputation, he derived the surname of *Scholasticus*. At Antioch he lived in habits of intimacy with Gregory, patriarch of that city, and when Gregory was charged with the crime of incest, and made an appeal to the emperor and a synod, Evagrius attended him to Constantinople, where his abilities and character were held in high estimation; nor was he less respected at Antioch, the place of his customary residence. The intervals of leisure which he could gain from the public duties of the several offices which he sustained, were devoted to the composition of his "Ecclesiastical History, in 6 books," comprehending the period from the year 430 to 594, and including the events that occurred from the close of the histories of Theodoret and Socrates till the twelfth year of the emperor Mauricius. His books of "Epistles, &c." and "Panegyric Oration on Mauricius," &c. are lost. His history is, upon the whole, a work of industrious research, general information, and considerable merit; though it manifests, on the part of the author, a great degree of credulity. The writers of the Romish church extol him as the only Greek ecclesiastical historian who has maintained the doctrine of the true faith; and Photius represents his style as sometimes elegant and beautiful, often too redundant and luxuriant.

The original Greek of this history was published at Paris in 1544, in folio, by Robert Stephens; in 1612 at Geneva, in folio, accompanied with a Latin version; in 1679 by Valesius, with a new version and notes; and in 1720 this last edition was republished at Cambridge in folio, with many additional notes. Cave. Valesii Præf. Dupin.

EVANDRIA, in *Ancient Geography*, a small town of Spain, in Lusitania, according to Ptolemy; supposed to be "Talavera la Veja."

EVANDRIUS MONS, one of the seven mountains, forming the site of the city of Rome, called also mount Palatine.

EVANGELICAL *Harmony and Economy*. See the substantives.

EVANGELISTS, the inspired authors of the Gospels. See Matthew, Mark, Luke and John. The symbols of these in the order now recited, according to Jerom, are a man, a lion, a calf or ox, and an eagle. According to St. Augustine, in his interpretation of Ezekiel, ch. i. 5.—10. and Rev. iv. 7, they are a lion, a man, an ox, and an eagle.

The word is derived from the Greek, *ευαγγελιστας*, formed of *ευ*, bene, well, and *αγγελος*, angel, messenger.

The denomination evangelists was likewise given in the

ancient church to such as preached the Gospel up and down, without being attached to any particular church, being either commissioned by the apostles to instruct the nations, or of their own accord, abandoning every worldly attachment, consecrated themselves to the sacred office of preaching the Gospel.

In which sense some interpreters think it is that St. Philip, who was one of the seven deacons, is called the evangelist, in the twenty-first chapter of the Acts of the Apostles, ver. 8. Again, St. Paul writing to Timothy, Ep. ii. chap. iv. ver. 5. bids him do the work of an evangelist. The same apostle, Eph. iv. 11. ranks the evangelists after the apostles and prophets.

EVANGELISTS, in *Geography*, four small islands at the western extremity of the Straits of Magellan, near the coast of South America; three are low, and one, at some distance, appears like a hay-stack. S. lat. 52° 45'. W. long. 67° 16'.

EVANIA, in *Entomology*. See SPHEX.

EVANID, a name which some authors give to those colours which are transient, or not of long duration; as those in the rainbow, in clouds, before and after sun-set, &c.

Evavid colours are the same with those otherwise called fantastical and emphatical colours. Some authors also use the same term to express those flowers of plants whose petals fall off as soon as they are opened.

EVANS, JOHN, in *Biography*, was born at Wrexham, Denbighshire, in the year 1680. His father was one of the ejected ministers in 1662, who, on account of his non-conformity, being driven from the established church, became minister to an independent congregation at Wrexham. The son was educated with great care, and inducted to the different branches of literature necessary to qualify him for the office of the ministry, which he afterwards exercised in London, first as an assistant, and afterwards as successor to Dr. Daniel Williams. He died in the year 1730, in the fifty-first year of his age, highly esteemed by all who knew him. He had ever been eminent for piety, integrity, and public spirit; in his principles he was orthodox, but disposed to think well of, and to honour, those who differed from him, without any regard to the sentiments which they might hold. He received a diploma of doctor in divinity from the universities of Edinburgh and Aberdeen. His principal work as an author consisted of two volumes of sermons, entitled "Practical Discourses concerning the Christian Temper," which are still in considerable estimation. The celebrated Dr. Watts characterized them as "the most complete summary of those duties which make up the Christian life." Gen. Biog.

EVANS'S ISLAND, in *Geography*, a small American island, near the coast of Main. N. lat. 44° 31'. W. long. 67° 3'.

EVANSHAM, a town of America, the capital of Wythe county, in Virginia, situated on the E. side of Reedy creek, which falls into the Great Kanaway, Woods or New River. It contains a court-house, gaol, and about 25 houses; 40 miles W. by S. from Christiansburg.

EVANTES, in *Antiquity*, the priestesses of Bacchus, thus called, because in celebrating the orgia they ran about as if distracted, crying *evan, evan, ohe evan!*

The word is formed from *Ευας*, a title or appellation of Bacchus.

EUANTHI COLORES, in *Painting*, a term used by the Greeks to express what the Romans call the *floridi colores*; these were such colours as had a remarkable brightness in their works. The other duller and coarser colours the Romans called *austeri colores*, and the Greeks *bathyvi*.

Of the first sort were cinnabar, lapis armenus, chrysofolia, minium, indigo, and purpurissa, according to the Romans; but the Greeks, as we find by Dioscorides, made cinnabar one of the austere colours.

EUAPHION, (from *eu, ease*, and *αφρ, the touch*;) in *Surgery*, a medicine for the hemorrhoids, named from its gentleness. Galen.

EVAPORATION, in *Natural Philosophy*, is that process by which water and other liquids are converted into vapour or steam, an elastic fluid, and dissipated in the atmosphere. Certain solid bodies, too, are subject to a similar dissipation in air; this is usually denominated *exhalation*: but as the cause is no doubt the same in both cases, it may be properly considered under this head.

The spontaneous evaporation of water, or that which is constantly going on in a greater or less degree from all parts of the surface of the globe, has always been an interesting phenomenon to the speculative philosopher. Various hypotheses have been advanced to account for the ascent of water into the atmosphere in an invisible form, and for its subsequent descent in the form of rain; but the opinions of early writers on this subject are of little importance, as they were not acquainted with the principal facts and experiments which ought to guide us in the investigation. Aristotle seems to have ascribed the formation of vapour to the action of fire; and so far his notion was correct. Halley supposes small hollow spheres of water to be filled with a subtle elastic fluid, so as to make them specifically lighter than air; he also hints at a chemical affinity between air and water, similar to that between water and salts. Desaguliers, after having shewn the insufficiency of former hypotheses, proposes a new one; he asserts that water is capable of being converted by heat into an elastic fluid much lighter than air, and refers to the steam engine as a proof; he shews, too, that a glass vessel filled with water, and inverted in another vessel of water, and then exposed to the heat of ebullition, has its water expelled, and steam, an elastic invisible fluid, takes its place. This steam, he shews, is again condensed into water as the vessel cools. He argues that steam is  $16\frac{1}{2}$  times lighter than air, and that when formed at a low temperature it must ascend in the atmosphere till it meets with air of the same density, and there it will stop; but when accumulated, the cold condenses a portion of it into drops of water: hence clouds and rain. This notion, which goes to identify vapour in the air, with the steam or vapour of water formed by heat in a vacuum, is ingenious and apparently original, but how the vapour should ascend till it arrives at air of the same density, is not very easily conceivable: for the vapour, in ascending, must expand as the pressure is diminished, according to the established laws of elastic fluids, and therefore never can obtain the same density as the air. The vapours might indeed ascend to the top of the atmosphere, and form a distinct stratum, as some have imagined with respect to hydrogen gas. The author has extravagantly under-rated the specific gravity of steam, or aqueous vapour, which is certainly at least one-half that of atmospheric air. Upon the whole, this hypothesis was more plausible than that adopted by Halley.

As the science of chemistry gradually expanded, the phenomena of evaporation began to be considered as most nearly allied to those of chemical solution. From the year 1743 to 1766 the essays of Nollet, Franklin, Roi, Hamilton and others, tended to establish the opinion that water is taken up into the air by chemical solution, in a similar way to that in which water and other liquids dissolve salts. In the 55th vol. of the *Philosophical Transactions*, there is an essay of Professor Hamilton on evaporation, in which he in-

sists at large on the hypothesis of solution. Hot water, he observes, dissolves salts sooner and in greater quantities than cold water, and deposits a part of the same on cooling: so warm air takes up more water than cold air; but the water is deposited again when the air cools, or by the contact of a cold body, as a glass of cold water. Evaporation always produces cold; this is observed when any part of the human body is moistened with water, and the same suffered to evaporate, but still more remarkably when moistened with ether or other fluids more evaporable than water; in like manner, certain salts dissolved in water constantly produce cold. In short, the points of resemblance between evaporation and chemical solution are so numerous and striking, that the generality of philosophers seem to have adopted the idea that air possesses a chemical affinity for water, and attaches a portion of it to itself, which becomes incorporated with the elastic mass of the atmosphere, under the denomination of vapour; till cold, or some other cause, reduces it again to the state of water.

In the year 1783, Saussure of Geneva published his celebrated essays on hygrometry, in which the subject of evaporation is discussed much more largely than had been previously done. This author does not claim the merit of any new theory; for, he says, "the conversion of water into elastic vapour has been known time immemorial; the dissolution of water in air was discovered by Roi, and the vesicles, which compose fogs and clouds, were conceived by Halley, and ocularly demonstrated by Kratzenstein. But no philosopher has, I believe, clearly distinguished the different modifications of vapours: all the systematic authors have endeavoured to reduce all vapours to one and the same species, whilst in reality they exist under forms absolutely different. It had not been perceived that water, on being dissolved in the air, is converted into an elastic fluid; but I have shewn this to be the fact by the most exact experiments; and further, the precise effect which the solution of a given quantity of water in air has upon the specific gravity of the air. Finally, the laws according to which the humidity of the air varies in proportion to its condensation and rarefaction, form an entirely new subject, on which our ideas hitherto have been vague and erroneous. These, I believe, will be found to have received a satisfactory elucidation." Preface, page 10. Before we examine the conclusions of Saussure, it may be proper to advert to the facts which are alluded to above. Having procured a large glass balloon, containing  $4\frac{1}{2}$  cubic feet of air, Saussure adapted to it a manometer or instrument to measure the force of elastic fluids; the balloon being filled with air of the natural humidity, the manometer, or thermometer, and a vessel containing caustic alkali of a given weight, were all enclosed in the balloon, and confined from the action of the external air. The caustic alkali absorbed the vapour in the balloon, and the manometer shewed the diminution of elasticity consequent thereon; after the experiment was carried as far as was desired, the balloon was opened, and the increase of weight of the alkaline vessel was ascertained. Hence were derived data for calculating the influence of vapour on the elasticity of the air, and likewise the whole quantity of water in a state of vapour in a given bulk of air. This might be called the analytic experiment; but the synthetic one was also made. By enclosing a piece of wet linen of a given weight in the balloon containing air as dry as possible, along with the other instruments, the moisture of the linen evaporating increased the elasticity of the confined air a quantity which could be observed; and at the close of the experiment the loss of weight of the linen indicated the quantity of water which had been evaporated,

## EVAPORATION.

and had increased the elasticity. The two methods were thus found to corroborate each other remarkably well. The results were, that at the temperature of  $64^{\circ}$ , a quantity of extremely dry air acquires an increase of  $\frac{1}{4}$ th in elasticity in attaining extreme humidity; and *vice versa*: that a cubic foot of air takes up 10 grains of water in passing from extreme dryness to extreme humidity; and that consequently it diminishes the specific gravity of the air, as if a volume of elastic fluid, equal in weight to 10 grains, and of  $\frac{2}{3}$ ths the specific gravity of air were added to it. Of the general accuracy of these results there is no room for doubt. They form a valuable acquisition to this branch of science. One important fact was still wanting; as air was supposed to dissolve water by virtue of an affinity, it was reasonable to expect that every species of air would have its peculiar affinity, or take up a certain portion of water peculiar to itself, agreeably to what is observed in other cases of chemical saturation. Saussure ascertained this point clearly in regard to inflammable and fixed air, that is, hydrogen and carbonic acid. Both these gases were found in their pure state, and when mixed with any proportion of common air, to affect the hygrometer in the same way as common air, and to promote evaporation in the same degree. In short, there was not any appearance to indicate that they contained either less or more vapour than common air in like circumstances. Saussure found that evaporation was accelerated in proportion to the rarefaction of the air; this circumstance he accounted for by observing that the pressure of the atmosphere retards evaporation; however, upon the principle of solution, it might have been expected that the greater quantity and density of the solvent would have compensated for the greater pressure. The condensation of air, on the contrary, uniformly tends to make it deposit moisture, and retards evaporation. This he explains by observing, that the solvent power of air does not increase quite so rapidly as its density; continued condensation therefore must first saturate the air with moisture, and then make it deposit a portion. Saussure found that warm and dense air required more vapour to saturate it than cold and rare air; he was led too hastily to ascribe the solvent power of the air partly to its temperature and partly to its density; but it has since been proved that temperature alone is concerned, and the density has no effect whatever. On the head of rarefaction and condensation, Saussure adverts to a curious fact, known by every philosopher, but not satisfactorily explained by any one; namely, the abundant and instantaneous formation of a cloud or mist upon exhausting a receiver by the air-pump. As the rarefaction of air is found to promote evaporation, it appears astonishing at first sight that the air should exhibit signs of super saturation at the same instant. When the pump plate is covered with wet leathers the above appearance never fails; but the abbé Nollet found it to take place when water was totally excluded. Saussure, however, denies this to be the fact; he thinks that water must not have been excluded with sufficient care in Nollet's experiments; and affirms that from his own experience no appearance of mist was found upon exhaustion, when the pump was carefully dried. The hygrometer at the time was  $70^{\circ}$ , extreme moisture being  $100^{\circ}$ . As the two authors here appear to be at issue as to the fact, the writer of this article, from his own experience, can venture to affirm that both of them may still be correct. When care is taken to exclude water from the pump and receiver, the mist is by no means so copious as otherwise; it is also more diminutive as the air is dry or far from extreme humidity; with both these circumstances and a large receiver, no mist will appear by a moderate rate of exhaustion; but

it may always be produced by using a small receiver, and rapid exhaustion. Saussure's explanation of the fact is very inadequate, and unworthy of repetition; he further notices the dew observed on the receiver of an air-pump after letting in the air, and very justly ascribes it to the condensation of the vapour raised up into the receiver after exhaustion; the air taking in with it nearly as much vapour as it is capable of holding. Upon liberating condensed air a great mist is observed in the receiver; Saussure explains this in the same unsatisfactory manner as before, and that in one case only, namely, when the receiver contains water; but his explanation does not apply when the receiver is perfectly dry; yet the phenomenon of mist is equally apparent in that case. The true explanation is, that a great but momentary cold, of  $50^{\circ}$  or more, occasions the precipitation of vapour, both upon rarefying air and liberating condensed air. The fact has since been demonstrated by Mr. Dalton; but it was hinted at by Lambert, as quoted by Saussure, page 331.

Though Saussure does not affect to introduce any new theory on the subject of evaporation, he certainly advances some notions on the subject that were not previously held by others, especially by those who adopted the chemical solution of water in air. He says, "evaporation, properly speaking, is the result or rather the effect of the intimate union of elementary fire with water; by this union the water and fire combined form an elastic fluid specifically lighter than air, and which is peculiarly distinguished by the name of *vapour*. This vapour being formed in a vacuum, or otherwise when the heat is sufficient to give it force superior to atmospheric pressure, so as to expel the air from any vessel in which it is formed, is called *pure elastic vapour*." Page 361. This representation is, in all probability, correct, and will be generally adopted without hesitation. He proceeds: "but when the vapour cannot entirely surmount the pressure of the air, it penetrates it, mixes with it, undergoes a true solution, and may then be properly called *dissolved elastic vapour*." Page 362. Certainly the advocates for the solution of water in air cannot adopt this language. Pure elastic vapour is first formed; then by means of such force as it happens to have, which is generally small, it penetrates and mixes with the air; afterwards it is dissolved by the air; that is, the particles of air finding those compound particles of water and fire amongst them, attract them, and form triple compounds of air, water, and fire. Here the business for which solution is called in is performed before hand; for we must suppose it to be the affinity of air for water which enables the latter to rise at all against so superior a pressure. If the vapour can, by virtue of its elasticity, penetrate the air, why may it not continue there by virtue of the same elasticity? Saussure proceeds; "when afterwards the air saturated lets fall the water which it contains, this water sometimes takes the form of vesicles or bubbles; these vesicles, filled and surrounded with a subtle elastic fluid, are supported in the air, and even sometimes rise in it, by their less specific gravity. These vesicles are essentially distinct from the air, as well as from the vapour above defined; but according to custom I have arranged them in the class of vapours, and distinguished them by the name of *vesicular vapour*. Finally, when the elastic vapour, or the vesicles themselves, condense into solid drops, which only differ from drops of rain by their extreme smallness, they are still very different from vapours properly speaking. Notwithstanding, as these small particles float in the air, and can even be supported in it for some time, by its agitation and viscosity, I have classed them also amongst vapours, and given them the name of *concrete vapours*." Page

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Page 363. It may be proper to observe here, that the vesicular vapour of Dr. Halley was supposed to be transparent, and therefore to correspond to the *dissolved elastic vapour* of Saussure. It was moreover hypothetical; but Kratzenstein and Saussure affirm that the small visible particles floating over steaming water, as well as those of certain fogs, are discernible by a microscope to be hollow or vesicular. These visible particles are the *vesicular vapour* of Saussure. Though it is by no means improbable that the vapour issuing from warm water is enveloped in a film of water, just as we see it in ebullition, and that the same bubble of steam on cooling may shrink into a vesicle, containing an atom of air, the original nucleus of the steam; yet it is not equally probable that in the condensation of pure vapour a vesicle should be formed: still less likely is it that sometimes vesicles, and at other times solid drops, should be formed. Microscopic observations on atoms dancing about in the air are scarcely to be relied on. But whatever may be the fact as to the constitution of condensed vapour, that is, whether the particles are hollow or solid, there is not any sufficient reason for supposing them constituted of any other principles than water and atmospheric air. The only one that has been advanced in support of the hypothesis is, that without some subtle elastic fluid, internal or external, the watery particles constituting clouds must constantly descend; whereas clouds are seen to remain stationary and sometimes even to ascend, which, it is alleged, could not take place, were not the particles of less specific gravity than the air. Now the ascent of clouds is in all probability an optical deception. It is occasioned by the dissolution or evaporation of the under surface of the cloud, and the superior new formation of a cloud. We have no sufficient reason for believing that the individual particles of clouds ascend; yet they frequently descend with a velocity almost imperceptible; this arises from the resistance the air makes to the motion of small bodies, which, it is well known, increases in proportion as their diameters decrease. The epithet *vapour*, which denotes an elastic fluid, cannot, with philosophical propriety, be applied to the visible particles of water constituting clouds.

Mr. Pictet of Geneva published an ingenious essay on fire, which was translated into English and published in 1791. This gentleman, impressed with such ideas of the powers of fire in every thing which relates to evaporation, is tempted to look upon it as the sole agent in this class of phenomena, and to renounce the idea that air acts in the manner of chemical *dissolvents*. He observes, "the very specious arguments of my learned colleague (Saussure,) in his hygrometry in favour of that opinion, had long seduced me; but the charming simplicity which the theory of evaporation would acquire if we could divest it of the agency of air; the possibility I perceive of reducing the whole to the action of fire; the probability which increases with the simplicity of every natural hypothesis, attract me, I confess, still more forcibly." Page 222.

In the *Philos. Transac.* for 1792, there is an essay of De Luc on evaporation. This acute philosopher distinctly maintains that vapour in the air is precisely the same as vapour in vacuo, and in both cases is formed by the intimate union of fire with water; he denominates it *steam*, and shews that steam in air of any density, and steam in vacuo, affect the hygrometer alike, provided the steam has the same temperature and elasticity, at least within the ordinary range of atmospheric temperature. He strengthens his opinion of steam in air, and in vacuo being the same from the fact that cold is produced, or heat absorbed, by evaporation in both cases. From the facts as ascertained respecting steam by Mr. Watt

and others he justly infers, that there is a certain minimum distance of the particles of steam for each temperature, at which they retain their elasticity; if they are condensed by any mechanical force within the limit of this distance, they lose their elasticity and become water; if not, they retain it, and act as any other permanently elastic fluid. In speaking of steam in air, he observes, "that no mechanical cause can produce the decomposition (condensation) of that fluid, but by forcing its particles to become nearer each other than the actual temperature can admit, which cannot happen in the atmosphere, except by the accumulation of steam itself in some part of it." "He concludes that the product of evaporation is always of the same nature, namely, an expansible fluid, which either alone, or mixed with air, affects the manometer by pressure, and the hygrometer by moisture, without any difference arising from the presence or absence of air, at least without any perceived hitherto."

In 1793, Mr. Dalton published a volume of meteorological essays, in which he gives a theory of vapour, very nearly allied to that of De Luc above-mentioned, and to the opinion of Pictet, though he seems to have been unacquainted with these circumstances. From the results of certain experiments and observations he concludes, "that the vapour of water (and probably of most other liquids) exists at all times in the atmosphere, and is capable of bearing any known degree of cold without a total condensation, and that the vapour so existing is one and the same thing as *steam* or vapour of 212° or upwards. The idea, therefore, that vapour cannot exist in the open atmosphere under the temperature of 212°, unless chemically combined therewith; I consider as erroneous; it has taken its rise from a supposition that *air* pressing upon vapour condenses the vapour equally with *vapour* pressing upon vapour, a supposition we have no right to assume, and which, I apprehend, will plainly appear to be contradictory to reason and unwarranted by facts; for, when a particle of vapour exists between two particles of air, let their equal and opposite pressures upon it be what they may, they cannot bring it nearer to another particle of vapour, without which no condensation can take place, all other circumstances being the same; and it has never been proved that the vapour in a receiver from which the air has been exhausted, is precipitated upon the admission of perfectly dry air. Hence then we ought to conclude, till the contrary can be proved, that the condensation of vapour exposed to the common air does not in any manner depend upon the pressure of the air." *Essays*, p. 201.

In 1802, Mr. Dalton published, in the fifth vol. of the *Manchester Memoirs*, a series of interesting essays relative to evaporation; he found, 1st. The expansive force of pure steam over water in vacuo at all temperatures from 32° to 212°; 2d. The expansive force of dry air for the same range of temperature; and, 3d. The expansive force of dry air in contact with water for the like range. From a comparison of these experiments it appeared that the observation of De Luc was universally true; namely, that steam in vacuo and steam in air are precisely of the same force at the same temperature. The law was found to apply equally to the steam from ether and other liquids, and to other elastic fluids, as well as common air. Mr. Dalton considers these facts to be decisive as to the nature of the connection between steam and air, and infers that steam forms a mechanical mixture with air, and not a chemical compound, as some have supposed. This conclusion was confirmed by experiments upon the quantity of water evaporated at different temperatures; which was always in proportion to the elastic force of vapour at the temperature. For instance, water at 212°, or kept just boiling, evaporates twice as fast as wa-

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ter of 180°, and this twice as fast as water of 150°; and the forces of pure steam at those temperatures are 30, 15, and 7½ inches of mercury respectively. The rule, however, does not apply without a correction for low temperatures; because the steam already in the air prevents in degree the ascension of fresh steam; whereas in high temperatures, the small portion of steam commonly in the air is too trifling to have any observable effect. Mr. Dalton has given a table founded upon experience, and adapted to the above-mentioned law, by which not only the actual quantity of water evaporated in atmospheric temperatures may be ascertained, but also the quantity of vapour existing in the air may be found, provided the rate of evaporation is given. The following is an abstract of it.

The first column of the table expresses the temperature; the second, the corresponding force of vapour in vacuo, derived from experiment; the third column expresses the number of grains of water evaporated per minute, from a surface of 28¼ square inches, in a moderate current of air or nearly calm; the fourth is the like evaporation in a medium current; and the fifth is the evaporation when a strong breeze exists, or a rapid current of air sweeps over the evaporating surface. The air is supposed to be perfectly dry or free from vapour; otherwise every particular state of atmospheric vapour would require a table. The table is intended to be used when we want to find the quantity of water evaporated from a given surface by the slow and gradual operation of the atmospheric temperature, or what has been called *spontaneous* evaporation. But as it is adapted to air perfectly free from vapour, it cannot be of any practical utility without further data. The force of vapour actually existing in the atmosphere at the time must be first ascertained, by determining the temperature at which dew begins to be formed on a glass, &c. containing cold water or a cold mixture. Then the force due to that temperature must always be subtracted from the whole force due to the given temperature of the evaporating water.

Whole evaporating force, per table, for 60° = 2.70 grains.  
 Existing force of atmospheric vapour for 50° = 1.92 grains.  
 Remainder - - - = .78 grains.

Hence a surface of 28¼ inches would lose 780 dths of a grain in each minute.

Again; suppose the atmospheric vapour to be at 20°, with a strong breeze, in one case, the air being 32°; and the atmospheric vapour to be at 50°, in another case, with calm air at 58°; query the rates of evaporation in those two cases?

1st Case. Whole evaporating force per table, for 32° - - - = 1.26 grains.  
 Existing force of atmof. vap. for 20° = .82 grains.  
 Remainder, or rate of evaporation = .44 grains.

2d Case. Whole evaporating force, per table, for 58° - - - = 1.96 grains.  
 Existing force of atmof. vap. for 50° = 1.50 grains.  
 Remainder, or rate of evaporation = .46 grains.

Hence it appears that under the circumstances above-mentioned the evaporation would be nearly the same in both cases.

*Problem 2.*—Having given the rate of evaporation, to find the quantity or force of atmospheric vapour.

Suppose the evaporation from a surface of 28¼ inches is found to be one grain in a minute, with a medium breeze, the temperature being 70°; query the quantity and force of atmospheric vapour?

Whole evaporating force, per table, at 70° = 3.70 grains.  
 Observed evaporating force - - - = 1.00 grains.

Remainder = existing atmospheric force 2.70 grains, which corresponds to 60°, for the temperature at which the atmospheric vapour would be found to be condensed at the time.

Mr. Dalton contends that all the different gases constituting the atmosphere, namely, azotic, oxygenous, carbonic acid, and steam, are independent of each other; so that they press the surface of the earth and other bodies with their own weight only, when in a state of equilibrium. Whence he considers the *quantity* and *force* of steam in the atmosphere as synonymous terms. Thus in the above example, the force of steam of 60° being represented by .524 parts of an inch of mercury, the weight of the incumbent atmosphere of steam must be the same, or equal to 7 inches of water nearly. This notion, concerning the whole quantity of steam in the atmosphere incumbent upon any place, is entirely new; and, if correct, must be of the first importance in meteorology.

Though the reasons assigned by De Luc and Dalton for the non-condensation of steam, already existing in air, appear to be incontrovertible, yet from what has been said above, no sufficient reason has been given by either of them for the *entrance* of steam of low temperatures into the atmosphere. How does steam of ½th part of the force of the atmosphere at first penetrate it? Even Saussure speaks of the fact, and as if there were no difficulty attending it. De Luc does not attempt any explanation. Dalton seems to have been fully aware that the hypothesis of pure steam existing in air was not tenable without obviating this difficulty. Accordingly he conceived that the particles of steam are not repulsive to those of air, but only to other particles of steam; hence the new formed steam has a kind of vacuum, to enter in the pores or interstices of the air. But this, it is thought by many, is going into the other extreme, and

TABLE.

Temperature	Force of vapour in Inch. of Mer.	Grains of Water evaporated.		
		Lowest	Mean	Highest
212°	30.00	120	154	189
20°	.129	.52	.67	.82
25	.156	.62	.79	.97
30	.186	.74	.95	1.17
35	.221	.80	1.14	1.39
40	.263	1.05	1.35	1.65
45	.316	1.26	1.62	1.99
50	.375	1.50	1.92	2.36
55	.443	1.77	2.28	2.78
60	.524	2.10	2.70	3.30
65	.616	2.46	3.16	3.87
70	.721	2.88	3.70	4.53
75	.851	3.40	4.37	5.34
80	1.000	4.00	5.14	6.29
85	1.17	4.68	6.07	7.46

*Problem 1.*—Having given the quantity or force of atmospheric vapour, to find the rate of evaporation,—

Suppose that atmospheric vapour begins to be condensed at 50°, and the temperature of the air is 65°; query the rate of evaporation, with a medium breeze?

making the facility much too great; besides, there is no notion so general and so probable, as the one that heat is the cause of repulsion; and if this notion be true, the particles of steam cannot be admitted to be repulsive of each other, and indifferent to those of air. Mr. Dalton, it seems, now considers the inequality in the size of the ultimate particles of different elastic fluids to be the cause why they are constantly diffusing themselves through each other, and never obtain a proper equilibrium till their particles take the arrangement, which they would do in a vacuum; and the elevation of steam from the surface of water, he supposes, takes place, because certain particles of the surface are in a great measure exempt from the pressure of the atmosphere. See *New System of Chemical Philosophy*, p. 190.

From the experiments of Mr. Watt on steam, it appears that evaporation at high and low temperatures is much the same as to the expenditure of heat for a given weight of water.

The evaporation from ice of 32° does not differ materially from that of water, at the same temperature. Electricity is said to promote evaporation in some degree.

*Evaporation in Meteorology.*—With respect to the natural evaporation of water from the surface of the earth, the experiments of Mr. Hoyle and Mr. Dalton, of Manchester, are nearly the only ones that are sufficiently numerous from which to draw any conclusions. They took a cylindrical vessel of tinned iron, 10 inches in diameter, and three feet deep; there were two pipes folded into it, one at the bottom, the other at the top, for the water to run off into bottles. The vessel was filled with gravel, sand, and soil, and subsequently the soil was covered with grass and other living vegetables. It was nearly buried in the ground in an open situation, and provision made for placing bottles to the two pipes. In this manner it was exposed to receive the rain, and to suffer evaporation from the surface, the same as the surrounding green ground. A regular register was kept of the water which percolated through the soil and gravel into the bottles; and a rain gage of the same surface was kept close by, for the sake of comparison. The results are contained in the table below, together with the mean evaporation from a like surface of water, for the three succeeding years.

Water through the two Pipes.				Mean.	Mean Rain.	Mean Evap. from Ground	Mean Evap. from Water.
1795	1697	1798	Inch.				
January	Inch. 1.90	Inch. .68	Inch. 1.77	Inch. 1.45	Inch. 2.46	Inch. 1.01	Inch. 1.50
February	1.78	.92	1.12	1.27	1.80	.53	2.00
March	.43	.07	.34	.28	.90	.62	3.50
April	.22	.30	.18	.23	1.72	1.49	4.50
May	2.03	2.44	.01	1.49	4.18	2.69	4.96
June	.17	.73	—	.30	2.48	2.18	6.49
July	.15	.03	—	.06	4.15	4.09	5.63
August	—	—	.50	.17	3.55	3.38	6.06
September	—	.98	—	.33	3.28	2.95	3.90
October	—	.68	—	.23	2.90	2.67	2.35
November	—	1.04	1.59	.88	2.93	2.05	2.04
December	.20	3.08	1.88	1.72	3.20	1.48	1.50
Rain	6.88 30.63	10.95 38.79	7.39 31.26	8.41	33.55	25.14	44.43
Evap.	23.75	27.84	23.87				

From this table it appears that the evaporation from a surface of water, is nearly twice as much as from green ground; also, that about eight or nine inches of rain are left for the supply of springs and rivers. This surplus of water must be evaporated from the sea, and return to it again by the rivers.

*Evaporation in Chemistry.*—When artificial heat is applied, the quantity evaporated will be nearly in geometrical progression to the excess of temperature, above that of the air. It is always nearly in proportion to the surface exposed. When the liquid is much below the margin of the vessel, the evaporation is greatly retarded.

*Evaporation in the Arts.* In certain arts, such as dyeing, printing, &c. quick evaporation is expedient. This is effected by exposing the wet pieces in a stove, which has commonly a fire and long flues from which the heat is dissipated into the room. The cold air should be admitted into the room as near the fire and flues as possible; and several small openings at the top of the stove should be made to suffer the vapoury air to escape.

See the articles **CLOUDS, DEW, DISTILLATION, HYGROMETER, RAIN, STEAM, &c.**

*EVAPORATION, in Pharmacy, Chemistry, &c.* denotes an operation by which the more aqueous and volatile parts of fluids are spent, or driven away in steam, so as to leave the remaining part stronger, or of a higher consistence than before.

Evaporation is effected by setting a liquor over a gentle heat, to carry off the most fluid and volatile parts, without lessening the quantity of the other matters with which the liquor is impregnated.

The vessels used for this purpose are basons, tests, or crucibles, which are made of glass, metal, or earth, according to the nature of the bodies on which the operation is to be performed. They are flat, shallow, and wide, so that the body from which the evaporation is to be made may present a large surface to the air. In all evaporations the degree of heat ought to be proportioned to the volatility of the substance to be evaporated, and to the degree of fixity of the substance intended to be left, and of its adhesion to the volatile parts. In some cases, as in obtaining oil from rectified spirit of wine and ether, the liquors ought to be evaporated upon the surface of water in open air, without any other heat than that of the atmosphere; in others, when the part to be evaporated is not very volatile, and when the remaining substance is very fixed, and does not adhere much to the volatile part, as in the purification of gold by antimony, a strong heat may be applied, and a current of air directed upon the surface of the body. Macquer.

**EVARCHUS**, in *Ancient Geography*, a river of Asia, forming the boundary between Paphlagonia and Cappadocia. Valerius Flaccus assigns it to Scythia, and says it abounded with swans.

**EVARISTUS**, in *Biography*, bishop of Rome, was elected to that office about the year 100, in which he continued eight or nine years. Much has been said of him with regard to his decretals; his distribution of Rome into parishes, his presenting Adrian with a book concerning the excellence of the Christian religion, and his martyrdom under the reign of that emperor; but these and other facts collected by modern writers do not stand on sufficient authority to obtain credit. Moreri.

**EVASION, EVASIO**, in *Law*, is used for any subtle endeavour to set aside truth, or to escape the punishment of the law, which will not be endured. Thus, if a person says to another that he will not strike him, but will give

him a pot of ale to strike him first; and accordingly he strikes, the returning of it is punishable; and if the person first striking be killed, it is murder; for no man shall evade the justice of the law by such a pretence to cover his malice. Hawk. P. C. 81.

**EUASPLA**, in *Geography*, a river of India, in the northern part of the mountain Paropamisus, which ran S.E. into the Indus.

**EVATES**, a branch or division of the ancient Celtic philosophers, the Druids.

Strabo distributes the philosophers among the Britons and Gauls into three sects; Βαρδοί, *Bards*, Ουατῆς, *Evates*, and Δρυῖδες, *Druids*. He adds, that the Bards were poets and musicians; the Evates, priests and naturalists; and the Druids, moralists as well as naturalists. But Marcellinus, Vossius, and Hornius, reduce them all to two sects, viz. Bards and Druids. Lastly, Cæsar, lib. vi. comprehends them all under the name of *Druids*; which see.

The Evates or Vates of Strabo might probably be what other authors, and particularly Ammian. Marcellin. calls *Eubages*; but Mr. Bouche, in his *Hist. de Provence*, lib. ii. chap. 2. distinguishes between them. The Vates, he says, were such as took care of the sacrifices and other ceremonies of religion; and the Eubages, those who spent their time in the search and contemplation of the great mysteries of nature.

**EVAUX**, in *Geography*, a town of France, in the department of Creuse, and chief place of a canton, in the district of Aubusson; 26 miles E. of Gueret. The number of inhabitants in the place is 2,081, and in the canton 8,036, and the territorial extent of 232½ kilometres includes 12 communes. Near it are a mineral spring and baths. N. lat. 46° 10'. E. long. 3° 33'.

**EVAX**, in *Botany*, Gærtn. v. 2. 393, see **FILAGO**.

**EVAZA**, in *Ancient Geography*, an episcopal see of Asia propria, under the metropolis of Ephesus; mentioned in the acts of the council of Ephesus.

**EUBAGES**, an order of priests or philosophers among the ancient Celtæ or Gauls. Chorier takes the Eubages to be the same with the Druids and Saronidæ of Diodorus. Others will have the Eubages to be those whom Strabo, lib. iv. p. 197. calls Ουατῆς, *Evates*, or *Vates*, on which principle there is room to conjecture, that the word should be written Ουαγῆς, it being easy to mistake a Γ for a Τ. See **DRUID**.

**EUBELSTADT**, in *Geography*, a town of Germany, in the bishopric of Wurzburg, on the Maine; three miles S. of Wurzburg.

**EUBŒA**, in *Ancient Geography*, one of the most considerable of the Greek islands, formerly joined to Bœotia, as Pliny informs us, by an isthmus, so narrow is the Euripus in some places, which separates it from the continent; and extending from north-east to south-west 150 miles; but where broadest being only 40 miles, and 20 where it is narrowest. In compass it is estimated at 365 miles. This island was anciently denominated Chalcis, Ellopia, Aonia, Abantis or Abantia, Macris, Oche, Bomo, &c. Its appellation Eubœa is said to be derived from a famous cave on the eastern coast of the island, called by the Greeks αυτη βοος, or the ox stall, and this name was probably deduced from its excellent pastures. Eubœa had several remarkable promontories, which stretched far into the sea; of these Pliny and Mela mention three, viz. Gerastus and Caphareus to the south, and Cenæum to the north; and Strabo mentions a fourth, which he calls Petalia, over-against Sunium. Cenæum, now Capo Liter, and Gerastus, now Capo Rosso, are, according to Strabo, 1200 furlongs distant from each other,

which measure exactly the length of the island, as it is set down by Pliny. The mountains of Eubœa are high, and covered during a great part of the year with snow. The famous city of Chalcis was situated under one of them of the same name, and on another, called Dryphis, was a temple dedicated to Diana. The following rivers are mentioned by Strabo, viz. Callas, Budarus, Cirocæus, and Neleus or Melas. The champaign country was exceedingly fertile, and yielded great plenty of corn, wine, oil, and all sorts of delicious fruits; but it was chiefly famous for its rich pastures. This island had in former times many cities of great note, which are mentioned by Strabo, Pliny, Ptolemy, and Mela. On the eastern coast stood the cities of Gerastus, which was a famous haven, Petalia, and Carystus, near which were the celebrated quarries of Carystian marble, so much valued by the Romans, and also of Amianthus or Asbestos. About five miles from Carystus was the village of Amarynthus, famous for a temple of Diana. On the same coast stood Eretria and Chalcis, which see respectively. Between Chalcis and the promontory Cenæum, stood the cities of Edepsum and Oreos; the former being famous for its hot-baths, and the latter one of the most powerful cities of Eubœa during the Trojan war, and occupying the fourth part of the island, in the time of Philip, the father of Alexander. The name Oreos was changed by the Athenians, when they became masters of the island by means of Pericles, into that of Isthiza, or Hestiza, which was the name of their tribe. On the north side of the island, opposite Thessaly, and extending from Cenæum to Artemesium, stood Dia, or Athenæ Diadæ; and on the coast, washed by the Ægean sea, stood the maritime city of Cerinthus. The inland cities mentioned by Strabo, Pliny, Ptolemy, &c. were Ellopia, Nyfa, Eubœa, Orabiz, Rhamnus, Porthmus, Algæ, and Tamyna.

Eubœa was probably one of the islands in which the first Orientals, who passed from the continent of Asia towards the coasts of Greece, made a settlement. It must have formed a very powerful state at an early period, since its king Elphenor conducted 40 ships to the war of Troy. Solinus ascribes the commencement of this monarchy to the Titans. Others suppose Abas to have been the first sovereign of Eubœa. The succession of its sovereigns is little known. In the time of Darius Hystaspis, the cities of Chalcis, Eretria, Carystus, and Oreos, formed distinct republics, governed by the nobles, whom they called hippobates, or horsemen; none being received into the government who were not able to maintain a certain number of horses. This oligarchy was not of long duration; but it was succeeded by a democracy, composed of domestic tyrants, who seized all power to themselves, and ruled in their several cities without controul. At length the Eubœans submitted first to Philip of Macedon, and then to his son Alexander, on whose death they endeavoured to shake off the Macedonian yoke; but they were again brought under subjection by Antigonus. When the Romans first passed into Greece, the kings of Macedon held this island in subjection; but it was soon after declared free by the senate, in order to weaken the power of Philip in these parts. But not being supplied with forces, they were unable to maintain their liberty; and fell under the power of Antiochus the Great, and Mithridates king of Pontus. The Romans, however, prevailing in the East, restored the Eubœans to their former state of liberty. It was not long before Marc Antony subjected them to Athens; but Augustus, incensed against the Athenians for assisting his rival, first gave freedom to the city of Eretria, and soon after to the whole island, which remained in a flourishing condition, under its own laws, till

the reign of Vespasian, when it underwent the same fate as the other states of Greece.

**EUBŒA**, the name of several towns in the island of Eubœa, Coreyra, and Lemnos.

**EUBULIDES**, in *Biography*, a native of Miletus, was a successor of Euclid in the Megaric school. He was a strong opponent of Aristotle, and seized every occasion of censuring his writings and calumniating his character. He introduced new subtleties into the art of disputation, several of which, though often mentioned as proofs of great ingenuity, deserve only to be remembered as examples of egregious trifling. They belong to that sophistical mode of reasoning, called by Aristotle eristic syllogisms. A single specimen will be sufficient. It shall be of the sophism, called from the example, "the Lying:" if, when you speak the truth, you say you lie, you lie; but you say you lie, when you speak the truth; therefore in speaking the truth, you lie. These silly inventions for perplexing plain truth were formerly in such high repute, that Chrylippus wrote six books upon the above mentioned sophism; and Philetas, a Choan, died of a consumption which he contracted by the close study he bestowed upon it. The inscription upon his tomb was Ὁ Δεδωμένος, "The Deceived." Brucker's Hist. Phil. by Enfield, vol. i. p. 192.

**EUCALYPTUS**, in *Botany*, from *eu*, well, and *καλυπτός*, covered, alluding to the peculiar lid which covers the calyx and encloses the organs of impregnation. L'Herit. Sert. Angl. 18. Ait. Hort. Kew. v. 2. 157. Willd. Sp. Pl. v. 2. 976. Mart. Mill. Dict. v. 2. Sm. Bot. of N. Holl. 39. Juss. 451. Class and order, *Cosmofandria Monogynia*. Nat. Ord. *Hesperideæ*, Linn. *Myrti*, Juss.

Gen. Ch. Cal. Perianth superior, of one leaf, abrupt, entire, permanent, closed before impregnation with a convex or conical, entire, deciduous lid, which is sometimes, if not always, of two or three layers. Cor. none. Stam. Filaments numerous, thread-shaped, equal, inserted into the margin of the calyx within the lid, and not expanding till after it falls, anthers roundish, two-lobed, small. Pist. Germen inferior, urceolate, firmly united with the base of the calyx, sometimes angular; style simple, columnar, about as long as the full-grown stamens; stigma simple, bluntish. Peric. Capsule roundish, crowned with the rim of the calyx, of three or four cells, opening at the top. Seeds numerous, angular, small.

Ess. Ch. Calyx superior, permanent, truncated, covered before flowering with an entire lid, which soon falls off. Capsule of three or four cells, opening at the top. Seeds numerous.

This genus was founded by the late M. L'Heritier in his Sertum Anglicum, upon a single species, from Van Diemen's land, named by him *obliqua*, and figured in the 20th plate of that work. Its description never appeared. The generic characters were by him communicated to the Hortus Kewensis, and adopted, with some necessary corrections, in Dr. Smith's Botany of New Holland, where a second species is figured, *E. robusta*, t. 13. This is called New Holland Mahogany, or Brown Gum Tree, and is one of the loftiest trees about Port Jackson, being often 100 feet high, and proportionably thick. The wood hard, heavy, strong, red and very resinous. Leaves alternate, stalked, ovate, entire, a little oblique and unequal. - Flowers in dense simple umbels, of a tawny yellow, on simple or divided angular stalks, growing in a corymbose manner about the ends of the branches. The lid in this species is conical, as long as the calyx and germen, with a striature in the middle; that of the former is short and hemispherical, with a minute point. Four more species from New South

Wales are described in the work last mentioned, and six additional ones by the same author in the Transf. of the Linn. Soc. v. 3. p. 283—288. All these 12 are adopted by Willdenow in his Sp. Pl. A new one, *E. marginata*, was added to this list by Dr. Smith in Tr. of Linn. Soc. v. 6. 302, who has since figured and fully described one of the most important of the former, *E. resinifera*, the Red Gum Tree, in his Exotic Botany, v. 2. 49. t. 84. This blossomed in Lady De Clifford's greenhouse at Paddington. The flowers are green with white stamens. Lid conical, twice as long as the calyx and germen, consisting of three coats, of which the outermost is formed of three ribs originating from the angles of the germen.—The tree produces an astringent resin of a fine deep red, whose probable uses in medicine or the arts merit enquiry. Many more species of this genus are said to abound in New Holland, all lofty trees, destitute of hairiness, with simple, lanceolate, or somewhat ovate, pointed, entire leaves, generally oblique, and often unequal, at the base; without stipulas. They are commodiously divided into two sections, by their hemispherical or conical lids.

**EUCARPIA**, in *Ancient Geography*, a town of Asia, in Greater Phrygia, according to Ptolemy and Strabo.

**EUCERA**, in *Entomology*, a genus of Hymenoptera; proposed by Scopoli, and adopted by various late writers. Under this denomination are comprehended those of the Linnæan genus *Apis* (bee), which have the mandibles horny, incurvated, acute, and toothless; jaw elongated, and membranaceous at the tip; lip horny, five-cleft; tongue inflected and seven-cleft; antennæ cylindrical, those of the male very long, and often exceeding the length of the body; the abdomen short and downy; tail of the female armed with a sting. The insects of this genus form cylindrical cavities in the earth, in which they deposit their eggs, each included in a separate cell, and furnished with a suitable provision of honey for the subsistence of the young when hatched. In the winged state the Eucera fly with great rapidity, and like the bee, collect the farina and nectar of flowers with great industry and activity. The females commonly differ much in appearance from the males of the same species, independently of the length of the antennæ.

#### Species.

**LONGICORNIS**. Black; summit of the head, thorax, and two first rings of the abdomen above grey-downy; rest of the abdomen nearly glabrous. Latreille. *Eucera longicornis*, Fabr. Kirby. Ap. Angl.

Native of Europe. The female of this species is not distinctly ascertained. Mr. Kirby seems to entertain no doubt of its being the insect figured by Panzer under the name of *Andrena strigosa*. Since his observations appeared, however, Latreille has written on the same subject, and though he does not refer to the remark of Mr. Kirby, he evidently alludes to it in the following passage, "Je doute que l'andrene, que Panzer nomme *strigosa*, soit la femelle de cette espèce. Son abdomen est très-différent par ses taches de celui de *Eucere longicorne* et cet insecte ne paroît qu'au milieu du Pête, tandis que le dernier ne se voit, qu'au printemps." The difference of the abdomen may perhaps be considered in this ambiguous race less definitive than the time of its appearance in the winged state; for if the first be constantly found only in the middle of the summer, and the other in spring, we should admit them to be distinct. It further merits observation that Latreille describes an insect which he imagines to be the true female, "La femelle, &c."—"The female, or, at least, that which I regard as such, and of which I have

have seen an individual in the collection of the naturalist Baumhaaver, differs only in the shortness of the antennæ; the head entirely black, and the posterior feet very downy." The species inhabits Europe.

**ATRICORNIS.** Antennæ black, as long as the body, which is hairy and ferruginous. Fabr.  
Native of Barbary.

**GLAUCA.** Antennæ ferruginous, as long as the body, the latter hairy and glaucous. Fabr. Sp. Inf. &c.

Inhabits the East; two first segments of the abdomen with a black band.

**LINGUARIA.** Antennæ black, length of the abdomen; thorax cinereous; abdomen black. Fabr.

Native of Europe, on flowers.

**TUMULORUM.** Antennæ length of the abdomen; body black; legs and jaws yellowish. Linn. Fn. Succ. *Eucera tumulorum*, Fabr.

An European insect, also found on flowers.

**GRISESCENS.** Antennæ black, as long as the body; the latter hairy and cinereous. Fabr.

Inhabits Barbary.

**ANTENNATA.** Antennæ as long as the body; abdomen black, with whitish streaks. Fabr.

A small insect, found in abundance in the environs of Paris in autumn, and also in other parts of Europe. The lip is marked with a trilobate spot of yellow; the head and thorax cinereous; abdomen glabrous; edges of the segments fringed with white, legs testaceous.

**CURVICORNIS.** Blackish-grey; antennæ convoluted, sub-clavated; abdomen roundish; margin of the wings black. Scopoli. Native of Carniola.

**BREVICORNIS.** Ferruginous hairy; abdomen brassy; antennæ short and black. Fabr. Suppl.

This is an inhabitant of Italy, and is described by Fabricius from the cabinet of Dr. Allioni. The head, thorax, and legs with ferruginous hairs.

**CRASSIPES.** Hairy cinereous; abdomen black, with the margins of the segments greenish; posterior thighs thick. Fabr. Suppl.

Native of Tranquebar in the cabinet of Lund. The antennæ of this insect are short; the wings are dusky with fuscous tip; legs yellowish; thighs of the posterior pair thick, dentated, and black; shanks incurvated, toothed, and yellow. Whether this and the species immediately preceding ought strictly to be placed with the *Eucera*, (so named from the length of their antennæ,) if they should be of the male kind, may be submitted with deference; the sex is not mentioned in either instance. Fabricius described them as *Eucera*, and they agree in every respect with that genus, except in the remarkable brevity of the antennæ.

**EUCHARIST, EUCHARISTIA,** the sacrament of the Supper, or a participation of the body and blood of Christ, under the species or figures of bread and wine. See **COMMUNION, SACRAMENT, SPECIES, TRANSUBSTANTIATION, and CONSUBSTANTIATION.**

The word in its original Greek, *Eucharistia*, literally imports *thanksgiving*, being formed of *eu*, *bene*, *well*, and *charis*, *gratia*, *thanks*.

**EUCHENDORF,** in *Geography*, a town of Lower Bavaria, on the Vils; 14 miles W. of Vilzhofen.

**EUCHERIUS,** in *Biography*, a bishop of Lyons in the fifth century, began his career in secular life, in the various offices of which he acquired wealth. He sustained the rank of senator, and having married, had several children, among whom were two sons, whom he lived to see advanced to the episcopal dignity. Wearied with the pursuits of the world,

he embraced a monastic life, which he quitted for the bishopric of Lyons in the year 434. He attended the deliberations of the first council of Orleans in the year 441, and was distinguished for his learning and sagacity. He was a popular preacher, upon those principles of grace which were vindicated by St. Augustine. He died about the year 454. Among the various pieces attributed to Eucherius, may be noted "Epistola de Laude Eremi, seu de Vita Solitaria," intended to extol the advantages of ascetic life, written, for the times, with uncommon beauty and purity of language: "Epistola Parænetica de contemptu Mundi, et Sæcularis Philosophiæ ad Valerianum Cognatum suum," which was published by Erasmus, with annotations, at Basil in the year 1520, and pronounced to be one of the most elegant pieces of antiquity. To these may be added two treatises intended to illustrate difficult passages of Scripture, of less value than those mentioned above. These, and some others attributed to Eucherius, were collected and published at Basil in 1531, at Rome in 1564, and are likewise to be found in the sixth volume of the "Bibliotheca Patrum." There was another Eucherius who was likewise a bishop of Lyons, and assisted at the second council of Orleans about the year 529. Moreri.

**EUCHITES,** or **ΕΥΧΙΤΑΙ,** in *Ecclesiastical History*, a sect of ancient heretics, who were first formed into a religious body towards the end of the fourth century, though their doctrine and discipline subsisted in Syria, Egypt, and other eastern countries before the birth of Christ; they were thus called because they prayed without ceasing, imagining that prayer alone was sufficient to save them.

Their great foundation was those words of St. Paul, Epist. i. to the Thessalonians, chap. v. ver. 17. *pray without ceasing.*

The word is formed of the Greek, *ευχη*, prayer, whence *ευχισταί*, the same with the Latin, *precatores*, prayers. They were also called *Enthusiasts* and *Mossalians*, a term of Hebrew origin, denoting the same as Euchites.

The Euchites were a sort of mystics who imagined, according to the oriental notion, that two souls resided in man, the one good and the other evil; and who were zealous in expelling the evil soul or dæmon, and hastening the return of the good spirit of God, by contemplation, prayer, and singing of hymns. They also embraced the opinions nearly resembling the Manichean doctrine, and which they derived from the tenets of the oriental philosophy. The same denomination was used in the twelfth century, to denote certain fanatics who infested the Greek and Eastern churches, and who were charged with believing a double Trinity, rejecting wedlock, abstaining from flesh, treating with contempt the sacraments of Baptism and the Lord's Supper, and the various branches of external worship, and placing the essence of religion solely in external prayer, and maintaining the efficacy of perpetual supplications to the Supreme Being for expelling an evil being or genius, which dwelt in the breast of every mortal. This sect is said to have been founded by a person called Lucope-trus, whose chief disciple was named Tychicus. By degrees it became a general and invidious appellation for persons of eminent piety and zeal for genuine Christianity, who opposed the vicious practices and insolent tyranny of the priesthood; much in the same manner as the Latins comprehended all the adversaries of the Roman pontiff under the general terms of *Waldenses* and *Albigenses*. Mosh. Eccl. Hist. Eng. edit. 8vo. vol. i. p. 350. and vol. ii. p. 441.

St. Cyril of Alexandria, in one of his letters, takes occasion to censure several monks in Egypt, who, under pretence of resigning themselves wholly to prayer, led a lazy,

lazy, scandalous life. A censure likewise applicable to monasteries in general.

**EUCHOLOGIUM**, *Ευχολογιον*, a Greek term, signifying, literally, *a discourse on prayer*.

The word is formed of *ευχης*, *prayer*, and *λογος*, *discourse*.

The Euchologium is properly the Greek ritual, wherein are prescribed the order and manner of every thing relating to the order and administration of their ceremonies, sacraments, ordinations, &c.

Fa. Goar has given us an edition of the Greek Euchologium in Greek and Latin, with notes, at Paris.

**EUCHROON**, in *Surgery*, a plaster mentioned by Scribonius Largus.

**EUCHYMIA**, from *eu*, *good*, and *χυμος*, *juice*, in *Medicine*, a good temper of the blood, or other juices and fluids in an animal body.

**EUCLABRIS**, in *Antiquity*, a table whereon the slaughtered victim was spread, in order to have its intestines carefully inspected. It was from this table that the vessels used in sacrifices were called *euclabria*.

**EUCLEASE**. The colour of this mineral is a very clear sea-green. It occurs only crystallized. Its primitive form is that of an oblique quadrilateral prism, but its summits are generally so complicated by truncatures and bevellings as to render a mere verbal description of it wholly unintelligible: in this state it resembles certain varieties of topaz, but may readily be distinguished by measuring the obtuse angles of the prism, which in this mineral are  $133^\circ$ , whereas in the topaz they are  $124^\circ$ ; its lamellæ also are not perpendicular to the axis of the prism. It has a brilliant vitreous lustre. Its fracture in the direction of its axis and parallel to the small diagonal of its base is perfectly lamellar; but when parallel to the large diagonal is very imperfectly so. Its cross fracture is somewhat conchoidal. It is transparent and has a double refraction. It is sufficiently hard to scratch quartz, but is remarkably brittle. Sp. gr. = 3.06.

When exposed to the blowpipe, it first loses its transparency, and then melts into a white enamel. It has been analysed by Vauquelin, with the following result:

Silex	-	-	-	-	35	to	36
Alumine	-	-	-	-	18	-	19
Glycine	-	-	-	-	14	-	15
Iron	-	-	-	-	2	-	3
<hr/>							
					69	-	73
Loss	-	-	-	-	31	-	27
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					100	-	100
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This mineral is so very rare that only a small portion could be afforded for analysis; of the loss, Vauquelin attributes the greatest part to water of crystallization, and the rest is probably alkali.

The euclase was found in Peru by Dombey, and all the specimens in the cabinets of Europe were brought over by this naturalist.

**EUCLEA**, in *Botany*, is derived by Professor Martyn from *εκλευα*, *glory*, or *celebrity*, which seems in no respect applicable to this plant. We would rather explain it by *eu*, *well*, and *ελευα*, *to shoot up*, because of the manifold coverings of the seeds, each of which is enclosed in an arillus, within the cell of a capsule, whose outside moreover is protected with a covering of pulp. To all this indeed L'Heritier first adverted, and not Linnæus nor Thunberg, one of whom probably invented the name. Linn. Suppl. 67. Thunb. Nov. Gen. 84. L'Herit. Sert. Angl. 31.

Schreb. 699, 700. Juss. 432. Class and order, *Dioclea Dodecandria*, or perhaps, as the Linnæan System now stands, *Polygamia Monoecia*. Nat. Ord. uncertain, Juss.

Gen. Ch. Cal. Perianth inferior, small, with five teeth, permanent. Cor. of one petal, larger than the calyx, in five deep, ovate, obtuse, equal, spreading segments. Stam. Filaments about fifteen, short, inserted into the receptacle; anthers erect, square, slightly downy, shorter than the corolla. Pysl. Germen superior, ovate, somewhat pyramidal; styles two, the length of the stamens; stigmas simple. Peric. Capsule with a pulpy coat, roundish, with three horns, three cells, and three valves. Seeds solitary, roundish, each enclosed in an arillus; one or two of them frequently proving abortive.

Ess. Ch. Calyx with five teeth. Corolla in five deep equal segments. Stamens 15. Styles two. Capsule superior, of three cells, pulpy-coated. Seeds solitary, enclosed in an arillus.

Obf. L'Heritier, from whom the above characters are taken, remarks that some flowers have an abortive germen, but he never saw any that were entirely female without stamens. Thunberg describes distinct male and female flowers, and asserts that the former are most frequently five-cleft, the latter four-cleft. Linnæus does not advert to any such difference.

Thunberg defines three species, all natives of the Cape of Good Hope, in his Prodrômus, p. 85.

1. *E. lancea*. "Leaves lanceolate, flat."
2. *E. racemosa*. "Leaves ovate, flat."—*E. racemosa*; Linn. Suppl. 428. L'Herit. Sert. Angl. 32. Ait. H. Kew. v. 3. 411. (*Padus foliis subrotundis, fructu racemoso*; Burm. Afric. 238. t. 84. f. 1; and *Euonymus foliis subrotundis integris, fructu corniculato*; *ibid.* 260. t. 97. f. 1. *E. africanus, foliis laurinis, fructu aculeato*; Breyn. Ic. 31. t. 22. f. 3.) A smooth branching shrub, with alternate, obovate, thick, somewhat revolute leaves, about an inch long, on short footstalks. Flowers eight or ten in each axillary drooping cluster, about as long as its corresponding leaf. Petals snow-white. Fruit red, the size of a pea.
3. *E. undulata*. "Leaves ovate, undulated."—Much like the last in general aspect. Its red fruit is eaten by the Hottentots, who call the plant *Guarri-boches*.

**EUCOLID**, in *Biography*, a native of Megara, and founder of the Megaric or Eristic sect, was distinguished by his subtle genius, and early application to the study of philosophy. Having acquired some knowledge of the art of disputation from the writings of Parmenides, he was induced by the fame of Socrates to remove from Megara to Athens, where he became the auditor and disciple of this eminent philosopher. Notwithstanding the terror of the decree which enacted, that any inhabitant of Megara who should be seen at Athens should forfeit his life, he frequently came to Athens by night, from the distance of about 20 miles, concealed in a long female cloak and veil, to visit his master. He also frequently engaged in the business and disputes of the civil courts, by which proceeding he offended Socrates, who despised forensic contests; and this circumstance seems to have occasioned a separation between them. Afterwards he put himself at the head of a school in Megara, where his chief employment was to teach the art of disputation. Although he was much addicted to vehement debates, he possessed so great a command of temper, that in a quarrel with his brother, who said to him, "Let me perish if I be not revenged upon you," Euclid replied, "And let me perish, if I do not subdue your resentment."

ferment by forbearance, and make you love me as much as ever."

Averse from the analogical method of reasoning, Euclid was of opinion that legitimate argumentation consists in deducing fair conclusions from acknowledged premises. He held, that there is one supreme good, which is called by the different names of Intelligence, Providence, God; and that evil, considered as an opposite principle to the sovereign good, has no physical existence. The supreme good he defined to be that which is always the same. Good he therefore considered abstractedly, as residing in the Deity, and he seems to have maintained, that all things which exist are good by their participation of the first good, and that in the nature of things there is no real evil. When Euclid was asked his opinion concerning the gods, he replied, "I know nothing more of them than this; that they hate inquisitive persons." Brucker's Hist. Phil. by Enf. v. i.

EUCLID, known to every well educated youth by his "Elements," was, according to the testimony of Pappus and Proclus, a native of Alexandria, in Egypt, where he flourished and taught the mathematics in the reign of Ptolemy Lagus, about 300 years before Christ. His was the first mathematical school in that far famed city, where, till its conquest by the Saracens, most of the eminent mathematicians were either born, or studied. To Euclid, and to those immediately educated by him, the world has been indebted for Eratosthenes, Archimedes, Apollonius, Ptolemy, &c. "The Elements," to which we have already referred, are not to be wholly attributed to Euclid, many of the invaluable truths and demonstrations contained therein were discovered and invented by Thales, Pythagoras, Eudoxus, and others; but Euclid was the first who reduced them to regular order, and who probably interwove many theorems of his own, to render the whole a complete and connected system of geometry. "The Elements" consist of fifteen books, but the last two are suspected to have been written 200 years after Euclid's death, by Hypsicles of Alexandria. The best edition published in this country is that printed at Oxford, in folio, in 1703; but the most common edition in our schools is that by the late learned Dr. Simson. Euclid is said to have been a person of agreeable and pleasing manners, and admitted to habits of friendship and familiarity with king Ptolemy, who once demanded of the mathematician if he could not direct him to some shorter and easier way of acquiring a knowledge of geometrical truths, than that which he had exhibited in his "Elements," to which Euclid replied, that "there was no royal road to geometry."

Euclid, as a writer on music, has ever been held in the highest estimation by all men of science who have treated of harmonics, or the philosophy of sound. As Pythagoras was allowed by the Greeks to have been the first who found out musical ratios, by the division of a monochord, or single string, a discovery which tradition only had preserved, Euclid was the first who wrote upon the subject, and reduced these divisions to mathematical demonstration.

His "Elements" were first published at Basil, in Switzerland, 1533, by Simon Gryneus, from two MSS. the one found at Venice, and the other at Paris. His "Introduction to Harmonics," (*Εισαγωγή ἁρμονικῆς*), which in some MSS. was attributed to Cleonidas, is in the Vatican copy given to Pappus; Meibomius, however, accounts for this, by supposing those copies to have been only two different MS. editions of Euclid's work, which had been revised, corrected, and restored from the corruptions incident to frequent transcription by Cleonidas and Pappus, whose names were, on that account, prefixed. It first appeared in print

with a Latin version, in 1498, at Venice, under the title of "Cleonidæ Harmonicum Introductorium:" who Cleonidas was, neither the editor, George Valla, nor any one else pretends to know. It was John Pena, a mathematician in the service of the king of France, who first published this work at Paris, under the name of Euclid, in 1557. After this, it went through several editions with his other works.

His "Section of the Canon," (*Κατάτομὴ κανόνος*;) follows his "Introduction;" it went through the same hands and the same editions, and is mentioned by Porphyry, in his Commentary on Ptolemy, as the work of Euclid. This tract chiefly contains short and clear definitions of the several parts of Greek music, in which it is easy to see that mere melody was concerned; as he begins by telling us, that the science of harmonics considers the nature and use of melody, and consists of seven parts: sounds, intervals, genera, systems, keys, mutations, and melopœia; all which have been severally considered in the dissertation.

Of all the writings upon ancient music, that are come down to us, this seems to be the most correct and compressed: the rest are generally loose and diffused; the authors either twisting and distorting every thing to a favourite system, or filling their books with metaphysical jargon, with Pythagoric dreams, and Platonic fancies, wholly foreign to music. But Euclid, in this little treatise, is like himself, close and clear; yet so mathematically short and dry, that he bestows not a syllable more upon the subject than is absolutely necessary.

His object seems to have been the compressing into a scientific and elementary abridgment, the more diffused and speculative treatises of Aristoxenus. He was the D'Alembert of that author, explaining his principles, and, at the same time, seeing and demonstrating his errors. The musical writings of Rameau were diffused, obscure, and indigested; but M. D'Alembert, extracting the essence of his confused ideas, methodized his system of a *fundamental base*, and compressed, into the compass of a pamphlet, the substance of many volumes. See *Elemens de Musique, suivans les Principes de Rameau*.

According to Dr. Wallis, (*Phil. Transf. No. 242*, and *Lowthorp's Abridg. v. i.*) Euclid was the first who demonstrated that an octave is somewhat less than six whole tones; and this he does in the 14th theorem of his "Section of the Canon." In the 15th theorem he demonstrates that a fourth is less than two tones and a half, and a fifth less than three and a half; but though this proves the necessity of a temperament upon fixed instruments, where one sound answers several purposes, yet he gives no rules for one, which seems to furnish a proof that such instruments were at least not generally known or used by the ancients.

What Aristoxenus called a *half-tone*, Euclid demonstrated to be a smaller interval, in the proportion of 256 to 243. This he denominated a *limma*, or *remnant*; because giving to the fourth, the extremes of which were called *soni stabiles*, and were regarded as fixed and unalterable, the exact proportion of 4 to 3, and, taking from it two major tones  $\frac{3}{2} \times \frac{3}{2}$ , the limma was all that remained to complete the diatessaron. This division of the diatonic genus being thus, for the first time, established upon mathematical demonstration, continued in favour, says Dr. Wallis, for many ages. But this is further explained in other articles.

EUCOMIS, in *Botany*, from *ευχομῆς*, *having beautiful hair*, alluding to the leafy tuft of barren bractæas, which crowns the spike of flowers. See *COMA*.—L'Herit. Sert. Angl. 17. Ait. Hort. Kew. v. 1. 432. Schreb. 798. Willd. Sp. Pl. v. 2. 92. Mart. Mill. Dict. v. 2. (*Basilæa*; Lamarck Encycl.

Encycl. v. 1. 382. t. 239. Juss. 52. Venten. v. 2. 163. Fritillaria; Linn. Gen. 164.) Class and order, *Hexandria Monogynia*. Nat. Ord. *Coronaria*, Linn. *Alphodelis*, Juss.

Gen. Ch. *Cal.* none. *Cor.* of one petal, inferior, bell-shaped, regular, permanent, in six deep, equal, oblong, obtuse, spreading segments. *Stam.* Filaments six, shorter than the corolla, awl-shaped, dilated at the base and united by that part into a concave nectary, attached to the bottom of the corolla; anthers oval. *Pist.* Germen superior, ovate, with three furrows; style awl-shaped; stigma simple. *Peric.* Capsule ovate, three-lobed, of three cells. *Seeds* numerous, small, ovate.

Eff. Ch. Calyx none. Corolla inferior, in six deep, spreading, permanent, equal segments. Filaments united at their base into a concave nectary, attached to the corolla.

1. *E. nana*. Ait. Hort. Kew. v. 1. 432. Jacq. Hort. Schoenbr. v. 1. 47. t. 92. (*Fritillaria nana*; Linn. Mant. 223.) Stalk club-shaped. Leaves numerous, broad-lanceolate, crenate. Barren bractees elliptical.—Native of the Cape of Good Hope, as are all the known species. *Bulb* ovate, rather large. *Leaves* radical, about eight, pale-green, spreading, recurved, obovato-lanceolate, somewhat acute. *Stalk* solitary, a span high, green, swelling considerably upwards, bearing a short spike of green drooping flowers, surmounted with a tuft, about as long as the spike, consisting of elongated, elliptical, barren bractees. It is kept in the greenhouse, and flowers in the spring, but is scarcely cultivated except for the sake of curiosity.

2. *E. bifolia*. Jacq. Ic. Rar. v. 2. t. 449. Coll. v. 4. 215. Curt. Mag. t. 840. (*Melanthium maffoniaefolium*; Andr. Repof. t. 368.)—Stalk club-shaped. Leaves two, elliptical, depressed. Bractees all longer than the flowers, pointed, recurved.—The leaves are ribbed, entire, very broad. *Stalk* very short, green. Barren and fertile bractees uniform, and all longer than the flowers, which are sessile and erect.

3. *E. purpurea*. (*E. purpureocaulis*; Andr. Repof. t. 369.) Stalk club-shaped. Leaves numerous, obovate, obtuse, depressed. Fertile bractees shorter than the flowers; barren ones linear-lanceolate.—Drawn by Mr. Andrews in the garden of G. Hibbert, esquire.—The broad, depressed, numerous leaves; thick, violet stalk; and numerous, narrow, purple-edged leaves of the crown, readily distinguish this species.

4. *E. regia*. Ait. H. Kew. v. 1. 433. (*Fritillaria regia*; Linn. Sp. Pl. 435. *Corona regalis*, *lilii folio crenato*; Dill. Elth. t. 92, 93.)—Stalk cylindrical. Leaves tongue-shaped, crenate, depressed. Barren bractees elliptical.—This most resembles the first species in size, habit, colour, and the crenate edges of its leaves; but differs in its longer cylindrical stalk. It has been much longer cultivated than any other of the genus.

5. *E. undulata*. Ait. ibid. Curt. Mag. t. 1083. (*E. regia*; Redout. Liliac. v. 3. t. 175. *Basilæa*; Lamarck f. 1.)—Stalk cylindrical. Leaves ovate-oblong, undulated, spreading. Barren bractees almost as long as the spike.—Introduced in 1760 by Mr. Miller, who, from its blossoming in autumn, which is not invariable, named it *Fritillaria autumnalis*. *Stalk* taller than in the last. *Leaves* narrower and longer. Mr. Gawler observes that their undulations disappear as they decay.

6. *E. punctata*. L'Herit. Sert. Angl. t. 18. Curt. Mag. t. 913. (*Basilæa*; Lamarck f. 2.)—Stalk cylindrical. Leaves lanceolate, channelled, spreading. Spikes many times longer than the barren bractees.—The long narrow leaves, stalk elegantly speckled with violet, and especially

the great extent of the spike, which is about a foot in length, render this species very distinct. The corolla is of a very pale green. *Germen* violet. The bases of the leaves are externally spotted like the stalk. It flowers in June or July, and is easy of cultivation.

EUCRASY, of *eu*, well, and *κρᾶσις*, temperature, an agreeable, well-proportioned mixture of qualities, whereby a body is said to be in good order, and disposed for a good state of health.

EUCRYPHIA, in *Botany*, from *eu*, well, and *κρυπτος*, covered, because the flower-buds are concealed by a peculiar covering. Cavan. Ic. v. 4. 48. Class and order, *Polyandria Polygynia*. Nat. Ord. *Tiliaceæ*, Juss.

Gen. Ch. *Cal.* Perianth inferior, of five minute, ovate, equal, permanent leaves. *Cor.* Petals five, large, obovate, equal, spreading; covered before expansion with a deciduous veil, separating from the base into four segments. *Stam.* Filaments inserted into the receptacle, numerous, awl-shaped, shorter than the petals; anthers roundish, of two cells. *Pist.* Germen superior, ovate, striated; styles about 12, shorter than the stamens; stigmas simple. *Peric.* Capsule ovate, with a woody furrowed bark, bursting at the top and bottom into as many cells as there are styles, each remaining attached by two fibres to the receptacle. *Seeds* several, obovate, imbricated, each terminated by a small membranous wing.

Eff. Ch. Calyx of five small leaves. Petals five, covered before expansion with a deciduous veil. Capsule of many cells, separating at top and bottom. *Seeds* winged, imbricated.

1. *E. cordifolia*. Cavan. Ic. v. 4. 49. t. 372.—A fine tree gathered in Chili, by Louis Née, from whose herbarium Cavanilles described it. *Wood* red. *Branches* downy when young. *Leaves* opposite, on short stalks, ovate, obtuse, undulated and bluntly crenate, veiny, coriaceous; heart-shaped at the base; smooth above; downy and white beneath; scarcely two inches long. *Stipulas* none. *Flowers* axillary, solitary, each on a stalk about an inch long, with a few scales at its base. *Petals* white, turning red in drying. *Veil* of the flower externally downy.—It is commonly called in the country *Roble di Chile*, or Chili Oak.

EUDEMIA, in *Ancient Geography*, a small island of the Ægean sea, placed by Pliny in the Thermaic gulf.

EUDÆMON, JOHN ANDREW, in *Biography*, a learned Jesuit, was a native of Candia, and went to Rome in pursuit of knowledge, where he entered himself a member of the society of Jesus. He was afterwards professor of philosophy, and then of theology in the university of Padua. He was honoured with the esteem and friendship of Pope Urban VIII. who appointed him the chaplain to his own nephew cardinal Barberini, when he was sent papal legate into France. He died at Rome in 1625, leaving behind him in various publications many testimonials to his talents and learning. He was suspected to be the author of a work entitled "Admonitio ad Regem Ludovicum XIII." which attacked the authority of the kings of France, in matters of an ecclesiastical nature. This treatise brought the society, of which Eudæmon was a member, into great and general disrepute; it was likewise censured by the faculty of the Sorbonne, and the assembly of the clergy at Paris, and condemned by the parliament. Moreri.

EUDEMUS, in *Biography*, a name, it would appear, common to several physicians in different ages, of whom little is known with any degree of certainty or precision. One Eudemus is mentioned by Galen as contemporary with Herophilus, in the 37th age, and is compared with the latter in respect to his anatomical skill, especially relative to

the nerves. Another Eudemus is said to have suffered death for his crimes, in the year 31 of the Christian era. And others of the same name, as Eudemus the vendor of antidotes, Eudemus of Chio, are occasionally mentioned. See Eloy. Dict. Hist.—Le Clerc Hist. de la Médecine.

Eudemus of Rhodes was a pupil of Aristotle. The Ethics of Aristotle are inscribed to him, and some suppose them to have been written by him.

EUDES, duke of Aquitain, succeeded to his dukedom towards the close of the seventh century. When Pepin Herital laid claim to the royal authority in France, Eudes declared himself independent, and seized upon the remainder of Aquitain, and in a short time by force of arms made himself master of all the country lying between the Loire, the Ocean, the Pyrenées, Septimania, and the Rhone. In 721 he defeated Zama, lieutenant of the Saracen caliph, who had invaded Gaul, under the walls of Toulouse, but in a few years afterwards he found it necessary to make an alliance with Munuza, another Saracen general, to whom he gave his daughter in marriage. After this his country was completely over-run by the Saracens, over whom, by the aid of Charles Martel, he obtained, in 732, a complete victory, which delivered France from the Mahometan yoke. Eudes died in 735, leaving behind him three sons by his wife Valtrude, who was the near relation of Pepin. Moreri. Univer. Hist.

EUDES, JOHN, born at Rye in Lower Normandy, in the year 1601, was brother of the celebrated historian Mezerai, and received his education at Caen, under the care of the Jesuits, where he was afterwards entrusted with the superiority of the house belonging to the congregation. In 1643 he quitted the duties of this institution, and undertook the establishment of another, of which he became the first superior as well as founder. This was denominated "The congregation of Jesus and Mary," and the principal object of it was to provide a seminary for the instruction of young persons in piety and sacred knowledge, and to form a body of religionists, influenced by greater fervour and exaltation in their devotional feelings, than was encouraged by the regulations of the society of which he had been a member. He died in 1680, at the age of seventy-nine. He is described as having been an excellent and well-meaning man, but mystical and highly enthusiastic. As a preacher and instructor of youth, he was very popular; but his writings evince little knowledge and less judgment, though they exhibit a devotional spirit, tinged with large portions of superstitious credulity. The most remarkable of his pieces are (1) A treatise "On the Devotion and Office of the Heart of a Virgin; (2) "Man's contract with God;" and, (3) some particulars concerning a peasant in Normandy, whom he regarded as under divine inspiration, entitled "The life of Mary of the Vallies." Moreri.

EUDIOMETRY. This term is applied to those processes which have been employed to ascertain the purity, or, in other words, the degree of oxygenation of any gaseous mixture, and especially of atmospherical air.

A considerable variety of methods have been used by chemists, all of which, though essentially different, agree in acting upon the oxygenous portion alone, the azot being in all cases left as the unchanged residue. The following are the several methods employed.

*Of nitrous gas as an eudiometer.*—This was the first eudiometer used by Dr. Priestley in his original experiments on air, which immediately followed the discovery of oxygen by this illustrious philosopher. If nitrous gas be mixed with oxygen gas, in a glass jar over water, in the proportions in which they saturate each other, to form nitric acid, the

gases will totally disappear, a ruddy fume is seen at the moment of mixture, and the water will rise to the top of the jar, leaving unabsorbed only the unavoidable impurities of the gases. If, on the other hand, nitrous gas be mixed with atmospherical air, or any other admixture of oxygen and azot, the former alone of the two will be condensed by and with the nitrous gas, and the azot will remain unaltered. Hence by measuring the respective quantities of the gases employed, and the quantity absorbed, the purity of the atmospherical air may be ascertained, (supposing it known by previous experiment what are the exact proportions in which nitrous gas and oxygen saturate each other, and become totally absorbable by water.) Thus, for example, if 100 measures of nitrous gas be added to the same quantity of common air; and the two completely mixed, the bulk after such mixture will not be 200 measures, but only about 108, and consequently 92 measures will have been absorbed; which last, therefore, consist of all the oxygen of the air, with so much of the nitrous gas as has been employed to saturate it. This result Dr. Priestley was in habit of denoting, for brevity sake, by the expression that the air was of the purity of 108, by which he always meant that when 100 of nitrous gas, and 100 of the air to be examined were mixed, the residue after the mutual action of the airs was over, was of the number specified. The quantity of the two airs absorbed being known, the portion which is estimated to belong to the oxygen must therefore depend on the proportion in which nitrous and oxygen gases saturate each other, which requires another elementary experiment. Thus in the instance before us, if three parts of nitrous gas saturate one part of oxygen, the 92 parts which have disappeared are composed of 69 of the former gas, and 23 of the latter, and hence the composition of the 100 parts of atmospherical air examined, will be 23 of oxygen, and the remainder unabsorbed residue chiefly azotic.

A number of valuable experiments by Fontana, Ingenhousz, and especially by Mr. Cavendish, made on this subject, have shewn that different portions of the very same mixture of nitrous gas and oxygen will experience a prodigious difference of absorption according to the width of the tube in which they are mixed, the order of mixture, the time of standing together, the degree of agitation used, and other manipulations. Thus Mr. Cavendish observed, that if one measure of nitrous gas and as much common air be rapidly mixed, and immediately shaken, the absorption will be nearly half the entire contents, but if the airs are suffered to remain in contact for about a fourth of a minute before they are shaken, the absorption will be no more than about .8. The nature of the water also in which the experiment is made is found very materially to influence the result. By attending to every circumstance of the kind, Mr. Cavendish, with that admirable accuracy which distinguishes all the researches of this eminent philosopher, was enabled to obtain very satisfactory results as to the uniform nature of atmospherical air.

Still, however, the difficulties of employing this mode of analysis with sufficient precision in all admixtures of oxygen and azot have been found so great, and the apparent anomalies so numerous, that it has been long nearly abandoned by chemists, till of late the subject has been revived by Mr. Dalton, who has added some important observations, which require some notice in this place. (See the Manchester Transactions. New series.)

Mr. Dalton gives the following experiments:

If 100 measures of common air be thrown up to 36 measures of nitrous gas in a tube only 3-10ths of an inch wide,

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wide, and 5 inches long, and no agitation be used, in a few minutes the whole will be reduced to 79 or 80 measures, and exhibit no signs of either oxygen or nitrous gas, but will consist entirely of azot.

If on the other hand 100 measures of common air be thrown up to 72 of nitrous gas, in a wide vessel over water, such as to form a thin stratum of air, and an immediate agitation be used, both the oxygen and the nitrous gas will, as before, totally disappear, and the residue, as before, will also be 79 or 80 measures of azot.

If in the last experiment less than 72 measures of nitrous gas be used, there will be a residuum containing some oxygen; if more, the residue will contain nitrous gas.

From these elementary experiments Mr. Dalton infers that the oxygen, contained in 100 parts of common air, may unite totally either with 36 parts of nitrous gas, or with 72, double that quantity, but with no intermediate portion. To insure the former effect, the gases must be mixed in a narrow vessel without agitation; to insure the latter the vessel must be large, and the points of contact between the ingredients must be increased by agitation. But in the ordinary circumstances of the experiment, Mr. D. supposes that both these effects partially take place, so that one part of the oxygen unites with the nitrous gas in the smaller proportion, and another in the larger; and hence he accounts in a very ingenious and satisfactory manner for the greater part of the apparent anomalies which have been observed in the employment of nitrous gas in eudiometry. Therefore, he observes, to use nitrous gas for the purpose of eudiometry, we must attempt to form one or other of these combinations wholly, and he prefers that with the smallest proportion of nitrous gas, in the following way:

Take a narrow tube of the dimensions above given, add 100 parts of common air to about 36 of nitrous gas, and when the diminution is complete, without agitation, transfer the residue to another tube and measure it; then  $7\frac{1}{5}$ ths of the loss will be due to the oxygen present.

But a stronger objection arises against the employment of nitrous gas in its aeriform state, owing to the difficulty of obtaining this gas of uniform purity. From a very elaborate series of experiments on this subject, undertaken by Humboldt and Vauquelin, (*Ann. Chem.* tom. 28.) it appears that when nitric acid of any strength is poured upon copper wire (which is the usual mode of obtaining nitrous gas,) an effervescence more or less vehement takes place, and a gas is disengaged, consisting of nitrous gas, but always mixed with more or less of azotic gas, and sometimes nitrous oxyd, and it is this varying portion of azot which constitutes the chief difficulty and trouble in the employment of nitrous gas in eudiometry. The quantity of azot is found to depend largely on the strength of the acid being from about one-tenth or less to nearly half the entire gas. According to Humboldt, the degree of strength of acid which produces the purest nitrous gas, is that in which the specific gravity is about 1.15 to 1.17, or from 17 to 21 of Beaume's areometer. Mr. Dalton finds that nitric acid diluted with an equal bulk of water poured on copper and mercury, without any artificial heat being used, gives a nitrous gas nearly pure, or with only from two to three per cent. of azot.

The proportion of azotic impurity in any mixture of this with nitrous gas, is most conveniently ascertained by agitating the gas with a solution of green sulphat of iron, which absorbs the nitrous gas without materially affecting the other. This experiment was first made by Dr. Priestley, who found that the solution of iron acquired thereby a reddish or olive brown colour, and a very acid styptic taste.

Other chemists have also found a certain quantity of ammonia in the solution.

To obviate the objections brought against the use of nitrous gas, in the gaseous form, as an eudiometer, Mr. Davy has ingeniously applied to this purpose the solution of sulphat or muriat of iron, saturated with nitrous gas as above-mentioned; and this, with a few precautions, is found to answer with great precision, and to be applicable with little trouble to all cases of the analysis of gases where oxygen is one of the substances sought for. The mode of use in ordinary cases is as simple as possible. The gas is put into a graduated eudiometer tube, some of the solution is poured in, and by very gentle agitation for about a minute, the whole of the oxygen is absorbed. The chief precautions required are, not to use the same solution twice, to keep it in a well-stopped bottle, and particularly to remove it from the gas under analysis as soon as the utmost degree of absorption is produced, as after this time a small increase of bulk is again observable in the residue, owing probably to some evolution of gas from the solution. It is also found that if the solution be very highly impregnated with the nitrous gas, and much hasty agitation be used, a little of the nitrous gas escapes in the gaseous form into the eudiometer tube, which may be removed by the application of a little sulphat or muriat of iron. One cubic inch of the impregnated solution of moderate strength will absorb about five or six cubic inches of oxygen gas.

*Of the sulphurets as eudiometers.*—The eudiometer first employed by the illustrious Scheele, in his original experiments on the constitution of the atmosphere, so early as the year 1779, was a mixture of iron filings and flowers of sulphur, moistened with a little water. By confining a cup of this mixture under a jar of common air over water, this excellent chemist observed an absorption soon to begin, the water gradually rising in the jar for about eight hours, after which no further diminution took place, and the residuary gas consists chiefly of azot.

This valuable elementary experiment has been employed in eudiometry with great advantage, but modified considerably, and a few precautions must be taken to avoid inaccuracies. In the first place it is to be observed that this mixture of iron filings and sulphur is slow in its operation, and moreover, a quantity of hydrogen gas is given out towards the end, which mixes with the residuary azotic gas. To lessen the duration of the experiment the liquid alkaline or earthy sulphurets have been substituted to the mixture of iron filings and sulphur, with great advantage. When atmospherical air, confined in a tube, is shaken for a few minutes with a little of the liquid sulphuret of lime, potash, or soda, the whole of the oxygen is absorbed in a few minutes.

Guyton has proposed to hasten the absorption by heating the solution, but it has been found that in this case there is some danger of expelling from it a portion of sulphurated hydrogen gas, which would impair the accuracy of the experiment.

A more important source of error has been mentioned by Marti, (*Journal de Physique*, tom. 52.) which must be avoided. It appears from his experiments that liquid sulphuret of lime, (and probably the other liquid sulphurets,) when recently made, is capable of absorbing a portion of azot as well as oxygen, which, though small, is sufficient to affect materially the result of a delicate experiment. Marti found that when one measure of common air was shaken with 20 measures of the liquid sulphuret of lime, the entire absorption amounted to as much as 26 per cent. of the air. But of these it is known that only about 21 can

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be oxygen, and consequently about 5 of azot must have been absorbed. The experiment being repeated with the same solution, only 21 per cent. were now absorbed, so that the solution had been saturated with azot by the previous experiment. The same solution was then shaken with pure azot, but no absorption took place, which confirmed the fact of the previous saturation of the sulphuret with azot. On the other hand, when a perfectly fresh solution was used, which immediately after being prepared, had been allowed to cool in a well-closed bottle, and only a twentieth of its bulk of common air was confined with it, the latter in a few minutes had diminished full one-half.

It is easy to avoid errors from this circumstance. All that is necessary is, previously to using the liquid sulphuret as an eudiometer, to shake it for a few minutes in a bottle of common air, and it is never necessary to use more than about two measures of the sulphuret to one of common air. With these precautions, the sulphuret proves a very useful and accurate eudiometer.

*Of hydrogen gas as an eudiometer.*—This ingenious method was proposed and employed with great success by the celebrated Volta. It consists in mixing known proportions of pure hydrogen gas with the air to be examined in a very strong glass tube, through which a metallic communication is made, and detonating the contents by the electric spark. After the shock, a sudden diminution takes place, owing to the production of water by the detonation of the hydrogen with the oxygen contained in the air examined. The exact saturating proportion between the two gases has been variously given, but an excess of hydrogen should be used. One hundred parts of oxygen require at the highest estimation somewhat less than 200 of hydrogen for saturation; so that when equal bulks of hydrogen and *atmospheric air* are used, there is an abundant allowance of hydrogen. Mr. Dalton finds 60 of the latter sufficient for 100 of common air, and the diminution is very uniformly 60 parts with the above proportions; and hence, if common air contains 21 per cent. of oxygen, the saturating proportions of oxygen and hydrogen are 21 of the former to 39 of the latter.

The chief objection to the universal use of Volta's eudiometer is, that it requires an apparatus to give the electric spark, which cannot be always procured; and in all experiments of this kind it is particularly desirable to employ one uniform mode of experimenting where general results are to be established.

*Of phosphorus as an eudiometer.*—Phosphorus has two distinct modes of combustion in common air, according to the temperature to which it is raised. One of these is rapid, and attended with the evolution of a prodigious quantity of light and heat, and it occurs when phosphorus is heated a little above its melting point, or in common language is set fire to. The other takes place in a temperature not exceeding from 90° to 100° at the utmost, and is that in which the phosphorus emits copious fumes, white in the day-time but highly luminous in the dark, and without any sensible emission of heat. In either case the phosphorus is consumed, or oxygenated; but it is the slow combustion without sensible heat that is alone employed in eudiometry. The whole apparatus required for the purpose is simple and convenient of application. Nothing more is necessary than to fix a stick of phosphorus in a portion of glass tube run through a cork, which loosely fits the open end of the small jar which is to contain the air to be analyzed, and confine it by water. If the temperature is very cold, the process may be assisted by the warmth of the hand. The phosphorus is immediately surrounded by the white luminous fume, which slowly falls down to the surface of the water, during which

time the oxygen of the air is gradually abstracted by the vaporized phosphorus, and in consequence the bulk of the contained air is diminished. The absorption of oxygen is complete when the contained gas is no longer luminous, which, in a small jar with a stick of phosphorus that traverses nearly its whole length, requires about half an hour at the heat of from 70° to 80°. The process succeeds equally well at a lower temperature, though a longer time is required. The heat cannot be safely raised more than about 85° or 90°, without danger of kindling the phosphorus, which may be avoided by observing that it melts and becomes glossy just before it catches fire.

The exact operation of the slow combustion of phosphorus used in this experiment has been very happily explained by Goettling and Berthollet. When phosphorus is exposed to air at any temperature below that of rapid combustion, the first effect seems to be a solution of the surface in the azot of the surrounding air, and this phosphorized azot instantly unites with the oxygen, becomes thereby luminous, and phosphorus acid absorbable by water is generated. Hence it is (strictly speaking) only that portion of phosphorus which becomes dissolved in the azot which is the eudiometrical substance; and in confirmation of this it may be added that phosphorus inclosed in pure oxygen gas is not in any degree luminous, but remains perfectly inactive till the heat is raised to the point of strong combustion. On the other hand, if the purest possible azot is passed into a jar full of water, and containing a stick of phosphorus, the gas only becomes luminous for a very short time, after which this appearance ceases, but the azot continues to saturate itself with phosphorus. If now a bubble of common air or oxygen is let up into this phosphorized azot, the luminous appearance immediately returns, and continues so till all the oxygen is exhausted. Phosphorus, therefore, furnishes also an useful test of the purity of azot, by not becoming luminous in it, but by enabling it to become luminous as soon as a particle of oxygen is added.

One circumstance of importance should be added, which is, that azotic gas in saturating itself with phosphorus is found to expand about 1-40th of its bulk, which accounts for the apparent difference in the composition of common air as determined by phosphorus or by other eudiometrical substances. After all absorption has ceased, when phosphorus is used, the apparent loss is not more than from 20 to 21 per cent. of the atmospheric air employed, whereas with all the other eudiometrical processes the loss is from 21 to 22 per cent., but this difference may be chiefly accounted for by the expansion of the residual azot from its saturation with phosphorus. It is therefore more accurate to diminish the bulk of the residuum by 1-40th, and this diminution must be thrown into the side of the oxygen absorbed. In analyzing an air much more oxygenous than the atmosphere, in proportion as the azotic ingredient diminishes, the operation of the phosphorus in removing the oxygen becomes less rapid and powerful, and hence either a dilution with pure azot is adviseable, or some other eudiometrical test should be preferred.

The general results of all the operations of atmospheric air have established it as an incontestible truth, that scarcely any difference exists in the proportion of oxygen, whatever be the height, season of the year, climate, and temperature at which the experiment is made, and even where the greatest changes would be expected from vitiation of air by the respiration of crowded assemblies of people, and the like, the loss of oxygen is much less than would have been generally expected. Hence the utility of eudiometry as a measure of the purity of the atmosphere has much diminished since this

fact

fact has been established, but the numerous and acute researches to which the subject has led, have been of high importance to this difficult part of chemical research.

Several kinds of apparatus are used in eudiometrical experiments, some of which may be here described.

*Dr. Hope's eudiometer* is the following. (*Plate X. Chemistry, fig. 1.*) It consists of two parts, the lower of which is a short thick bottle, with an upper and a side opening, the latter closed by a glass stopper, and the other receiving a graduated tube closed at the top, and accurately fitted by grinding. To use it, take off the tube, and fill it quite full of the gas to be examined, and also fill the bottle with liquid sulphuret of lime, and, without shaking, sink it in water, and then immerse the open end of the graduated tube in the same water, and slide it upon the bottle and thrust it in. Then take out the bottle and tube, and shake them, to bring the sulphuret thoroughly in contact with the contained gas, and immerse the bottle from time to time in water, opening the side stopper to allow the water to rush in, and supply the vacuum made by the absorption of oxygen. This will indeed somewhat dilute the eudiometrical liquor, but not so much as to prevent it from acting. When all absorption is over, the quantity of residual gas is found by inspection of the scale of the graduated jar.

The apparatus for detonating oxygen and hydrogen, which forms Volta's eudiometer, consists of a very thick graduated glass tube, open at bottom, and towards the top are two sealed holes, admitting the wires by which the electric spark is taken. A very useful improvement in this apparatus has been introduced by Mr. Pepys, to prevent the violence of the shock, either from breaking the glass (with moderate quantities) or from throwing out any of the mercury when confined by this fluid. In this improved apparatus, the thick graduated jar is fixed to a heavy iron stand, which has a strong spring near the foot, that draws out in the manner of the steel-yard, when the concussion is given, and thus takes off the recoil. *Fig. 2.*

An improved and very useful apparatus for nice eudiometrical experiments, is given by Mr. Pepys in the *Phil. Trans.* for 1807, to which we shall refer our readers for a full description. It consists of a graduated tube, an elastic gum-bottle, furnished with a perforated glass stopper, closely fitting to the end of the tube, and another very small tube with a surrounding jar for the purpose of measuring quantities less than the smallest subdivisions of the larger graduated tube. The eudiometrical liquor is put into the elastic gum-bottle, and by pressure is injected strongly up into the larger tube, by which means the action is facilitated, and none of the liquor is spilled or wasted.

**EUDOCIA**, in *Biography*, a Roman empress, wife of Theodosius the younger, was daughter of Leontius, an Athenian philosopher. She was educated in the sciences and religion of ancient Greece, and so great were her mental acquirements and personal beauty, that Leontius divided his property between his sons, conceiving she could stand in need of nothing to recommend her to a proper husband. About the year 421 she was married to Theodosius, when she renounced the errors of paganism, and received the baptismal name of Eudocia, having previously been called Athenais. She was reconciled to her brothers; and, having invited them to court, conferred upon them offices of rank and power. Upon the throne, as in a more humble station, she cultivated letters, and employed her talents in the service of the religion to which she was a convert. She put into verse several of the books of the Old Testament, and wrote paraphrases on some of the Jewish prophets. She lived for a considerable time in harmony with her consort;

and after the marriage of her daughter to the emperor Valentinian III. she was permitted to pay her vows in a splendid pilgrimage to Jerusalem; and at Antioch she pronounced an oration to the senate from a throne of gold. After her return, suspicions were excited of her fidelity in the breast of her husband by his sister Pulcheria, who had been the means of bringing them together by marriage. The object of these suspicions was Paulinus, a handsome and accomplished man, who held high offices at court, and who was put to death on the occasion. Eudocia was reduced to a private condition, and allowed to seek a retreat in the Holy Land, where she had formerly obtained a high degree of credit by the magnificence of her presents. Here she devoted herself to religious and devotional studies, and died in 460 at the age of 67. In her last illness, she asserted in the most solemn manner her innocence of the crime for which she had been dethroned and suffered banishment. *Moreri. Gibbon's Hist.*

**EUDOCIAS**, in *Ancient Geography*, an episcopal town of Asia, in Pamphylia.—Also, an episcopal town of Asia, in the second Galatia.

**EUDON**, a river of Asia, in Caria.

**EUDOXIANS**, a party or sect of heretics in the fourth century, so denominated from their leader Eudoxius, a native of Arabissus in Armenia Minor, and patriarch of Antioch, to which he was advanced in 356, and Constantinople, to which he was promoted in 359, and which he retained till his death, in 370. He was a great defender of the Arian doctrine, though represented as somewhat fluctuating and unsteady in his principles. He is charged with being a bitter persecutor of the Catholics. Of his works, no remains are extant, except some fragments of a treatise "De Incarnatione Dei verbi;" to which Cave (*Hist. Lit.*) has referred.

The Eudoxians adhered to the errors of the Arians and Eunomians, maintaining that the Son was created out of nothing; that he had a will distinct and different from that of the Father, &c.

**EUDOXIOPOLIS**, in *Ancient Geography*, an episcopal town of Asia, in Pisidia.

**EUDOXUS**, the *Cnidian*, in *Biography*, was celebrated as an astronomer, a geometrician, a physician, and legislator, but was most particularly distinguished in the first of these characters. His first preceptor was Archytas, by whom he was instructed in the principles of geometry and philosophy: about the age of 23 he came to Athens. His knowledge of medicine is said to have been obtained in this way. A physician, named Theomodonus, observing the ardent desire which he manifested for study, notwithstanding his extreme poverty, presumed that he possessed talents which deserved cultivation, and therefore took him to his house, and afforded him every means of accomplishing his wishes, enabling him, as his own patrimony was small, to attend the schools of the philosophers, particularly that of Plato. Eudoxus afterwards went into Egypt, accompanied by a pupil, named Chrysippus, and here he was introduced by Agefilaus to king Nectanebis II., and by him to the Egyptian priests. He is highly celebrated by the ancients for his skill in astronomy; but none of his writings on this or any other subject are extant. Aratus, who has described the celestial phenomena in verse, is said to have followed Eudoxus; to whom is attributed the honour of bringing the celestial sphere and the regular astronomy from Egypt into Greece. Having left Egypt he taught astronomy and philosophy with great applause at Cyzicus, on the Propontis; and he afterwards removed to Athens, where he opened a school, and gained so high a degree of reputation,

reputation, that he was consulted on subjects of policy as well as sciences, by deputies from all parts of Greece. His death is generally referred to the first year of the 107th olympiad, 352 years before Christ. See Le Clerc. Hist. de la Med. Eloy.

Eudoxus is said by Fabricius (Bibl. Græc. lib. iii. c. 5.) to have written upon music, and he gathers from Theon of Smyrna, p. 94, that Eudoxus was the first who expressed the ratios of concords by numbers, and who discovered that grave and acute sounds depend on the slow or quick vibrations of the sounding body.

EUDRACINUM, in *Ancient Geography*, a town placed by the Itinerary of Antonine on the Alps, between Summus Penninus and Augusta Pætorina.

EUDRAPA, EDER, or *Edir*, a town of Asia, situated in Mesopotamia, W.S.W. from the town of Carmanda.

EUDROME, in the *Ancient Music*, the name of an air played by hautbois at the Sthenian games, instituted at Argos in honour of Jupiter. Hicorax the Argian was the inventor of this air.

EVE, the first woman, and mother of the human race. The history of her formation and other particulars is recorded in the Hebrew Scriptures (Gen. ii. iii. iv.); and it is needless to recite from Bayle and others the absurd fables invented concerning her by the Jewish rabbis.

EVE. See VIGIL.

EVEA, or EVA, in *Ancient Geography*, the ancient name of Byblos, a town of Phœnicia.

EVEA, in *Botany*, Aublet Guian. v. 1. 100. t. 39. Juss. 208. See CALLICOCCA, spec. 10.

EVECTION, in *Astronomy*, the most considerable of the lunar irregularities, and the first that was known to the ancient astronomers. It was discovered by Ptolemy. Its general and constant effect is to diminish the equation of the centre in the syzygies, and to increase it in the quadratures. If this diminution and augmentation were always the same, the evection would depend alone on the angular distance of the moon from the sun; but the absolute value of the evection depends likewise on the distance of the moon from the perigee of her orbit. After a number of trials and observations, it was found that this inequality could be represented very exactly by supposing it proportional to the sine of double the angular distance of the moon from the sun, minus the mean anomaly of the moon. The coefficient to this proportion is  $1^{\circ} 20' 30''$ .

The period of the evection differs but little from the periodic revolution of the moon: it is 27.178533 days. The evection is caused by the action of the sun upon the moon, and may be explained by supposing a change to take place in the excentricity of the moon's orbit, and at the same time a motion in the apogee.

Ptolemy supposed the epicycle of the moon to be carried along in an excentric circle, and that it was nearer to us in the quadratures than in the conjunctions and oppositions; so that to explain this inequality at the same time with the equation of the centre, he imagined an excentric and an epicycle. It is curious to trace the progress of these discoveries, and the history of the first observations of the evection has been transmitted in the words of Ptolemy himself. (Almagest. lib. v. cap. 1.)

In observing, says he, with care, the order of this inequality, we took notice that there was no other than the first and simple inequality in the conjunctions and oppositions, and even in the quadratures when the moon was in apogee or perigee, (meaning by the simple inequality the equation of the centre); but we may be assured that this is not sufficient to calculate the particular motion of the moon in other

aspects. The second inequality, (*i. e.* the evection,) is connected with the distance of the moon from the sun, and is re-established and disappears in the conjunctions and oppositions, and is greatest in certain quadratures. We discovered this inequality by the observations transmitted by Hipparchus, and by those which we have made by means of an instrument constructed for the express purpose of measuring the difference of longitude on the zodiac between the moon and the sun.

Ptolemy found that there was a difference of  $23^{\circ}$  between the observed and the calculated place (when the first inequality or equation of the centre was only used) when the moon in quadrature was three signs from the apsidæ. (Almagest. v. 3.) Then the sun being in the apogee or perigee of the moon, the inequality, which should have been  $5^{\circ}$ , was found  $7\frac{1}{2}^{\circ}$ ; to explain which he supposed the epicycle as above-mentioned.

Copernicus, to explain the evection, employed two epicycles. The small epicycle is supposed to describe the circumference of the great one in the space of an anomalistic revolution, and contrary to the order of the signs; while the moon describes the small epicycle contrary to the order of the signs in  $14^{\circ} 18'$ , or in the space of half a synodical revolution.

It was in this manner that the second inequality of the moon, called now the evection, was explained till the time of Tycho. It was called by Ptolemy "προσποσεισις, epicycli quasi annutum," by Copernicus "prosthaphæresim secundi vel minoris epicycli," by Tycho "prosthaphæresim excentricitatis," and by Bouillaud "evection," which name it still retains.

The evection was explained in a different manner by Horrox about the year 1640; but his theory was not made known till 1673, when Flamsteed calculated his new tables of the moon, upon the principles and numbers given him by Horrox. These tables were published in the posthumous works of Horrox in 1673. This hypothesis is the same with that of Arzachel, an astronomer who flourished in Spain in 1080, when that country was possessed by the Arabians, and who applied it to the motion of the sun. Let T be the centre of the earth (Plate XII. *Astronomy*, fig. 107.), C the mean place of the centre of the orbit which a planet is supposed to describe; so that TCA may be the line of the apsidæ, and TC the excentricity of the planet. If the centre of the orbit, instead of being fixed in C, be supposed to describe the circumference of a small circle ACB, there will result a double effect: 1. The line of apsidæ TA will change its position, and instead of remaining constantly in the direction TCA, it will pass, for example, into the position TG, and will make with the first position an angle ATG. 2. The excentricity, instead of being equal to the original quantity TC, will become TG, TB, &c. This hypothesis was invented by Arzachel to explain a supposed diminution of the excentricity of the sun's orbit, which he had inferred from some defective observations, and has not only been adopted by Horrox to deduce this inequality of the moon, but by Flamsteed, Halley, and Newton, for the same purpose.

Kepler had already announced that he employed an excentricity of the lunar orbit which varied every year; but Horrox was led likewise to this hypothesis by observations of the diameter of the moon; for about this time the application of micrometers to telescopes enabled astronomers to determine the apogee and perigee of the moon much more exactly than formerly. From these observations he perceived that the apogee of the moon was about  $25^{\circ}$  more advanced when the distance from the sun to the apogee

## EVECTION.

of the moon was  $45^\circ$  or  $225^\circ$ , than when it was  $135^\circ$  or  $315^\circ$ : hence the motion of the apogee, instead of being uniform, seemed to have an annual libration of more than  $12^\circ$ . This variation in the motion of the apogee being once known, its connection with a change of eccentricity was not difficult to be discovered. Both Halley and Newton employed the above hypothesis. According to the method of Newton the centre A of the orbit of the moon (*fig. 108.*) describes a circle ACB, the earth being at T. Thus TC expresses the mean eccentricity of the moon; TA the greatest eccentricity, and TB the least; TC being to CB as the mean eccentricity is to its difference from the least, or as the total sine is to the sine of  $12^\circ 18'$ , which is the greatest equation of the apogee. It is likewise supposed that if the angle ACG be taken equal to double the annual argument, or the distance between the sun and the mean apogee of the moon for a given time, the angle CTG will be the equation of the apogee, and TG the eccentricity for the same time. Then in the triangle TCG, the two sides and included angle being given, we have the sum of TC, and CG is to their difference as the tangent of half ACG, (or the annual argument, whose double is ACG,) is to the tangent of half the difference of the unknown angles. This is reduced to a constant logarithm, which added to that of the tangent of the mean annual argument, gives the annual argument corrected; and this, added to the place of the sun, gives the true place of the apogee of the moon. This is the form which Halley employed in his lunar tables.

It escaped the observation of Flamsteed, Halley, and Newton, that this equation might be calculated without supposing a variable eccentricity and libration of the apogee. Euler employed this method, of which the following is the demonstration.

Let L (*fig. 109.*) be the moon, T the earth, C the mean centre of the lunar orbit, G the centre for a given moment; CT the mean eccentricity of the moon, CLT the half of the mean equation of the orbit, because it is the double eccentricity which produces the whole equation; GLT the half of the evection for the time given, and represented in Newton's method by an augmentation of eccentricity; CLG is the difference of these two equations, or the effect which the change of eccentricity, and the libration of the apogee, produce upon the half equation. To find by a simple operation this angle CLG, which is the half of the evection, it must be remembered that when this angle is the greatest, or when LC is perpendicular to CG, the angle CLG is  $40'$ , that is, the constant relation between CL and CG is such, that the value of L can only be  $40'$  when it is the greatest, or  $1^\circ 20'$  for the whole evection. When the angle LCG is oblique, the angle CLG will diminish, and that in the ratio of the perpendicular GD to the line CG, or as the sine DCG to radius. Hence the evection will be  $80'$  sin. DCG; but the angle DCG = ACL - ACG is the mean anomaly of the moon, minus twice the distance of the sun from the moon's apogee, or what is the same, twice the distance of the moon from the sun, minus the mean anomaly of the moon, which forms the argument of evection.

The half evection, or angle GLC, is equal  $40'$  sin. (2 dist.  $\odot$  - m. anom.  $\text{D}$ .) This is the form in which it is usually found in the lunar tables.

When we come to treat of the theory of the moon, and the lunar inequalities, we shall have occasion to resume this subject, and to shew how correctly this equation is derived from the law of universal gravitation; we shall confine ourselves at present to a very general explanation of the physical cause of this phenomenon.

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When the sun corresponds to the apogee or perigee of the moon, that is, when the line of apsidæ of the moon coincides with the line of the syzygies, the central force of the earth upon the moon, which is the weakest in the syzygy apogee, receives the greatest diminution, and the central force, which is the strongest at the syzygy perigee, there receives the least diminution, therefore the difference between the central force perigee and the central force apogee will then be the greatest, and the difference of the distances will be augmented, that is, the eccentricity will become greater, and observation shews that the equation is then  $7^\circ 40'$ , whereas it does not exceed  $5^\circ$  when the line of the quadratures coincides with the line of the apsidæ.

The formula for the evection in the latest tables is  $1^\circ 20' 28''$  sin (2 dist.  $\odot$  - mean anomaly  $\text{D}$ ); from which it is easy to follow the successive variations of this equation, for it is only requisite to consider the different values which its argument can take. If it be required, for instance, to determine when it arrives at its maximum, we have only to investigate the case in which the angle 2 dist.  $\odot$   $\text{D}$  - m. anom.  $\text{D}$  becomes equal to  $90^\circ$ , or  $270^\circ$ , or its sine equal to unity, the evection will then be equal  $1^\circ 10' 21''$ : the first of these values will happen in the quadratures, when the mean anomaly is equal  $90^\circ$ , for then 2 dist.  $\odot$  =  $180^\circ$  2 dist.  $\odot$  - m. anom.  $\text{D}$  =  $180^\circ - 90^\circ = 90^\circ$ ; on the contrary, the evection will disappear, when the argument is zero or  $180^\circ$ , this will happen in the syzygies when the moon is either perigee or apogee, for then the distance of the moon from the sun is equal  $0^\circ$  or  $180^\circ$ , and the same of the mean anomaly. But by the various combinations of the two angles which form the argument of evection, the greatest and least values will arrive, even in several other points of the orbit. In general, in the conjunctions, the evection will have a contrary sign to the equation of the centre, for its argument is reduced to - mean anom.  $\text{D}$ , which gives a negative sign if the anomaly is less than  $180^\circ$ , and a positive sign if it is greater; but in the first case the equation of the centre is additive, and in the second it is subtractive. It is easy to comprehend that it will be the same in the oppositions, hence it follows that in the syzygies the evection is subtractive from the equation of the centre, on the contrary it is additive in the quadratures. Thus the first observers that examined the theory of the moon's motion only by means of eclipses, and with no other view but to predict those phenomena, always found the equation of the centre too small, by the quantity of the evection in the syzygies.

It is not difficult to find the period of the evection from the variations of the value of the angle on which it depends; it is sufficient to calculate the variations of this angle in a given time; and to conclude, by a simple proportion, the number of days necessary for it to vary  $360^\circ$ .

The synodical motion of the moon in one century is  $445267^\circ 6' 55''.46$ , multiplying this by two, we have  $890534^\circ 13' 50''.92$  for the double of the distance of the moon from the sun, after a hundred Julian years. If from this we take the anomalous motion of the moon, in the same interval, or  $477198^\circ 41' 30''.6$ ; the difference  $413335^\circ 32' 20''.3$  will be the value of the argument of evection, after 100 Julian years; from whence it appears, that this argument increases  $360^\circ$  in a number of days expressed by  $360.36525$ , or  $27.178533$  days; this is the period of the evection, after which period it successively takes again the same values.

From this it appears, that substituting, instead of these angles, their values calculated as above, the argument may be put in the form of a quantity proportional to the time;

for example, if we name the number of days elapsed since a given epoch as that of the tables  $t$ . The angle  $z$  di.  $D \odot$  —  $m$ . anom.  $D$  will become  $\frac{t \cdot 360}{27.178533}$ , and the evection may be represented under this form  $1^\circ 20' 28'' \left( \frac{360 \cdot t}{27.178533} \right)$  or simply  $1^\circ 20' 28'' \sin. m. t.$  making  $m = \frac{360}{27.178533}$ .

EVEILLON, JAMES, in *Biography*, was born at Angers in the year 1542; he was distinguished at a very early age for his literary acquirements, and obtained considerable ecclesiastical preferment, in the place of his birth, till at length he was made grand-vicar to the bishop. Eveillon was looked up to for his superior knowledge of the rights and usages of the church; and of every subject connected with the councils, the fathers, and the canon law. He was not unfrequently employed in matters relating to church discipline, the reformation of breviaries, rituals, and monastic institutions. His principal works were entitled "De Proceffionibus Ecclesiasticis, in quo earum Institutio, Significatio, Ordo, et Ritus explicantur."—"De reſta Pallendi Ratione;" and "A Treatise on Monitions and Excommunications," which has borne a high character in the Catholic communion. Eveillon died at the age of 79, in the year 1621. He was a man of extensive benevolence, having obtained the title of father to the friendless, and the poor, to whose relief he devoted the whole of a liberal income, excepting what was absolutely necessary for his own support. Moreri.

EUELPIDIUM, a kind of fluid collyrium.

EUELPISTI, a plaster described by Scribonius Lar-gus.

EVELYN, JOHN, in *Biography*, the son of Richard Evelyn, esq. was born at Wotton, in Surrey, in 1620. He received the early part of his education at Lewes, from thence he went to Christ church, Oxford. During the civil wars he spent his time on the continent, particularly in France and Italy. He married in the year 1647 the only daughter of sir Richard Browne, the king's minister at Paris, and returned to England about the year 1651, where he employed himself in literary occupations, chiefly in translating from the French and Latin. He was much inclined to a life of learned leisure; and in his zeal to forward a similar plan for others he formed a scheme for the erection of a college, where persons might live together in philosophical retirement, and in the pursuit of common studies. In 1657 he published a favourable account of the king's character, with a view of preparing his countrymen for the restoration of monarchy, and on the return of the exiled Charles, he was graciously received, and introduced into public life, though without abandoning his literary pursuits. In 1662 he published a curious and learned work, containing much useful and important information, entitled "Sculptura, or the History and Art of Chalcography, or Engraving on Copper." This piece was reprinted in 1755, with additions. Mr. Evelyn practised the art himself, and is introduced by Mr. Walpole into his catalogue of English engravers. On the institution of the Royal Society, he was nominated among the first fellows and members of the council, and he ever after continued a zealous and truly active member of that learned body. At some of the early meetings of the society was read his discourse on forest trees, which was the basis of the treatise entitled "Sylva, or a Discourse of Forest Trees, and the propagation of Timber in his Majesty's Dominions, to which is

annexed Pomona, or an Appendix concerning Fruit Trees, in relation to Cyder, &c." As a sequel to this work, he afterwards published his "Terra, a Philosophical Discourse of Earth, relating to the Culture and Improvement of it for Vegetation, and the Propagation of Plants." Both these works have been reprinted several times. The edition of the Sylva by Dr. Andrew Hunter, of York, is with plates of all the trees, in which their parts of fructification are accurately displayed according to the Linnæan system. Mr. Evelyn was appointed, at the desire of the king, in 1664, one of the commissioners of the sick and wounded seamen, and likewise a commissioner for rebuilding St. Paul's cathedral. How well fitted he was for the latter office was shewn by a work which he published, entitled "A Parallel of the Ancient Architecture with the Modern," translated from the French of Roland Freart, sieur de Chambray; with additions from Alberti and others. He resided at this period at his house of Sayes-court, near Deptford, which he had in right of his wife; here he cultivated a garden, and was regarded as a great improver of the art of horticulture and celebrated for the pains which he took in the introduction of exotics into this country. During the reign of Charles, a board of trade was formed, and Mr. Evelyn was appointed one of its members. On this occasion he drew up a small treatise on the origin and progress of navigation and commerce, with an assertion of the king's title to the dominion of the sea. Among the papers which he communicated to the Royal Society is a curious letter, given at length in the *Biographia Britannica*, describing the mischiefs done to his garden by the severe winter of 1683—4. This letter will be read with interest, as affording information of the perennials at that time chiefly cultivated in England, and as stating the dire effects of rigorous frost. We shall give the concluding paragraph:

"The vines have escaped, and of the esculent plants and sallads, most, except artichokes, which are universally lost; and what I prefer before any sallad whatever, eaten raw when young, my sampier is all rotted to the very root. The arborescent and other sedums, aloes, &c. though housed, perished with me, but the yucca and opuntia escaped. Tulips, many are lost, and so the Constantinople-narcissus, and such tuberosæ as were not kept in the chimney corner, where was a continual fire. Some anemonies appear, but I believe many are rotted. My tortoise, which by his constant burying himself in the earth at the approach of winter, I looked upon as a kind of plant animal, happened to be obstructed by a vine-root from mining to the depth he was usually wont to inter, is found stark dead, after having many years escaped the severest winter. Of fish I have lost a few, and the nightingales, which for being a short winged bird, and so exceedingly fat at the time of the year, we commonly suppose them to change the climate, whereas indeed they are then hardly able to fly an hundred yards, are as brisk and frolic as ever; nor do I think they alter their summer stations whatever may become of them all the winter."

In the reign of James II. Mr. Evelyn was, during the absence of the earl of Clarendon in Ireland, made one of the commissioners for executing the office of lord privy seal, and after the revolution he was appointed treasurer of Greenwich hospital. In 1697 he published a discourse on medals, entitled "Numismata, &c." and his last work was "Acetaria, a Discourse of Sallets," in which he treats of the nature and properties of all plants which have been employed as sallad herbs. This discourse was inscribed to lord chancellor Somers. The dedication, which is written with

much elegance, was intended to procure, if possible, a public establishment for the Royal Society. Mr. Evelyn died in Feb. 1706 in his 86th year, having passed his days in useful and elegant pursuits, and distinguished by benevolence, piety, and integrity. *Biog. Brit.*

EVELYN, JOHN, son to the former, was born Jan. 14, 1654, at his father's house at Deptford. He was at a very early age admired for his rapid progress in knowledge, so that in the year 1666 he was sent to Oxford under the special care of Dr. Bathurst, till he could be admitted a gentleman commoner, which was in the Easter term, 1688. It does not appear that he took his degrees there, but returned to his father's house, where he prosecuted his studies with much diligence and success. During his residence in Trinity college, he is supposed to have written the elegant Greek poem which is prefixed to the second edition of the *Sylva*. He became deeply learned in the ancient and modern languages, and cultivated poetry, of which there is evidence by a translation "Of Gardens, first written in Latin by Renatus Rapinus." This was published when the translator was a youth of nineteen years of age only. He afterwards translated Plutarch's life of Alexander the Great from the Greek; and from the French he gave a translation of "The History of the Grand Viziers, Mahomet, and Achmet Coprogli." He was likewise author of several poems, two of which have been chiefly admired, the one "On Virtue," and the other was entitled "The Remedy of Love," and have been inserted in Dryden's *Miscellanies*. Mr. Evelyn was a man of business as well as a cultivator of literature, and was appointed one of the commissioners of the revenue of Ireland. He died in the prime of life, in London, March 24, 1698, in the forty-fifth year of his age, leaving behind him two sons and three daughters. *Biog. Brit.*

EUE'MBOLOS, (from *eu*, *well*, *eu*, *in*, and *βωλλω*, *to cast*,) a person skilful in setting bones.

EVEN FOOT, in *Poetry*. See FOOT.

EVEN number, is that which may be divided into two equal parts or moieties. See NUMBER.

EVENELADS, in *Geography*, a river of England, in the county of Oxford, which runs into the Isis, about 5 miles W. of Oxford,

EUNES, a town of Norway, 18 miles N. of Drontheim.

EVENING STAR, in *Astronomy*. See VESPER.

EVENING island, in *Geography*, a small island in the Pacific ocean. N. lat. 2° 46'. W. long. 133° 17'.

EVENLY even number, is that which is exactly divisible by an even number taken an even number of times; such is 32, since it is divisible by 8, taken four times.

EVENLY odd number, is that which an even number measures by an odd one; as 30, which is measured by 6, taken five times.

EVENUS, in *Ancient Geography*, a river of Asia Minor, according to Pliny, who says that the towns of Lyrnessa and Miletus were built upon its banks. The inhabitants of Adramyttium drew water from this river by means of canals. Strabo.

EVENUS, *Fidari*, a river of Greece, in *Ætolia*, which took its rise towards the north-east in mount Pindus, on the frontiers of Thessaly, and passing through the territories of the Bomizei, Ophientes, and Apodoti, watered Calydon, and discharged itself into the sea; to the west is the town called Chalcis. It was on the banks of the Evenus that Hercules, according to the fable, slew the centaur Nessus.

EVERARD'S sliding rule. See SLIDING.

EVERBODE, in *Geography*, a town of France, in the department of the Dyle; 5 miles N. of Diest.

EVERDINGEN, CÆSAR VAN, in *Biography*, a painter of histories, portraits, and landscapes, born at Alkmaer in 1606. The master under whom he studied, Van Bronckhorst, soon observed and encouraged his superior talents from among the rest of his disciples. He had a lively invention, and painted with freedom and firmness, and a good force of colouring.

Many of his pictures are spoken of in terms of praise; but the one selected as his principal performance is the representation of the victory of David over Goliath. It was painted on the folding doors of the organ in the great church at Alkmaer; and the sketch of it was preserved in the council chamber of that city; it was painted in 1648. He died in 1679, aged 73.

EVERDINGEN, ALDRET VAN, a landscape painter, whose merit was very considerable. He was the nephew of Cæsar Van Everdingen, and was born in the same city, Alkmaer, in 1621. Having first attended to the instructions of Roland Savery, he afterwards greatly improved by those of Peter Molyn; whom at last he surpassed in skill. He delighted most in the grand scenes of nature, or rather her more romantic features, such as rocks, torrents, and cataracts, which he executed with great freedom and variety of touch. In his time he had no superior, but Jacob Ruyssdael followed him immediately, was indeed partly contemporary with him, and in his own style left him far behind in the brilliancy and force of his colours and execution, and the choice of his forms. However, Everdingen is highly deserving of great praise for the care which he took to make himself acquainted with the effects of nature, and the truth with which he marked them. He made a voyage up the Baltic, and was much gratified by and made much use of the scenery, which the romantic coasts of that sea, and of Norway, (which he also visited) afforded him. He died in 1675, and left behind him a great number of drawings, both of real views and compositions, which are very freely wrought. He was thought not to succeed so well in large works as in smaller ones, those coming more within the management of the neatness of pencilling, which characterizes his style of execution. The latter are very highly and very deservedly valued in Flanders and Holland.

EVERDINGEN, in *Geography*, a town of Holland, in Guelderland; three miles W. of Culemburg.

EVERET'S BRIDGE, a place of Nansemond county, in Virginia; where is a post-office; 266 miles from Washington.

EVERGEM, a town of France, in the department of the Escaut, and chief place of a canton in the district of Gand. The place contains 6878, and the canton 13,176 inhabitants, on a territory of 67½ kilometres and four communes.

EVERGETÆ, in *Ancient Geography*, a people of Asia, placed by Strabo in the vicinity of Diargiana.

EVERGETES, *Ευεργέτης*, a Greek term, signifying benefactor, being formed of *eu*, *well*, and *εργον*, *opus*, *work*. It is still retained in our language by way of addition or epithet given to two princes or kings of Syria and Egypt, who succeeded Alexander. Thus we say Ptolemy Evergetes, king of Egypt, Antiochus Evergetes king of Syria.

EVERGREEN THORN, in *Gardening*. See MESPILUS *Pyracantha*.

EVERGREEN Trees, are such trees, whether of tall or shrubby growth, as constantly retain their leaves during the whole year. There is a great number of this sort of

plants, which will be particularly described under their proper genera.

These kinds of trees, shrubs, &c. are increased in different modes, according to their particular nature, as by seeds, layers, cuttings, suckers, &c. which is fully shewn under the culture of the different sorts, but principally in the spring season, though occasionally in the summer, and frequently in the early autumn.

The proper seasons for planting them out are the early autumn or latter spring months, according to the nature of the soil. Where the soils are of the more stiff, retentive, moist kind, the more advanced spring months are the best; but where they are of the light, dry, loose description, the beginning of the autumn is the most proper period; as in the former case the plants will be in no danger of being injured by stagnant moisture in the winter, and in the latter there will be no risk of their being destroyed by the heat and dryness of the summer, before they become perfectly established in the ground.

In the planting of evergreen trees, it is seldom necessary to put them into any great depth, as they are very liable to be destroyed by deep planting. There is likewise another circumstance that ought to be regarded, which is that of having the mould in which they are to be set sufficiently fine, and the roots well bedded in it, without being too much cut in or retrenched. In all cases the loose mould should be well trodden in about them; and the more tall growing kinds well supported with strong stakes, so as to keep them perfectly steady in their situations. Numbers of trees of this, as well as other sorts, are destroyed for want of attention in this respect, as when once they get loose they soon die by the motion which takes place. The pruning or cutting in of this sort of trees, where it is necessary, should be performed either in the more advanced spring season, or the latter part of the summer, but never in the winter season, as they are liable to much injury from cold. This is equally necessary to be regarded in the clipping of hedges constituted of plants of this sort.

Many of these sorts of trees and shrubs are sufficiently hardy to admit of being planted in most sorts of soils and situations. The tall-growing kinds are well adapted for affording ornament and variety in mixture with those of the deciduous class in extensive plantations, and such as are of a shrubby growth in the borders, clumps, and other parts of ornamented grounds. In these situations they should be suffered as much as possible to take their natural growth, especially the fir kinds, and in the others only very little cut in, and the dead wood removed from them.

In the forming of hedges various plants of this sort are employed; but the best are those of the holly, yew, evergreen privet, and box kind; though the common laurel and laurustinus may be the most adviseable, where they are required to be lofty. These are likewise capable of being trained so as to cover naked walls, palings, or other unpleasant objects. Hedges formed of these plants should be clipped once or twice during the summer season, so as to keep them in perfect neat order.

Various ornamental devices were formerly made with these and other sorts of evergreens in gardens; but these are at present little in use, as a better and less troublesome taste prevails.

It has been remarked by the author of "The Philosophy of Gardening," that in these sorts of trees and shrubs the buds rise in the bosoms of the leaves, which, as they are not shed in the autumn, continue to oxygenate the juice of the plants, and supply nutriment to the buds during the fine days in the winter and spring seasons, surviving till

nearly the middle of summer, when the new buds have expanded leaves of their own. It is hence conjectured, that evergreens provide no store of nourishment in their roots, or albumen in the summer for the support of their ensuing vernal buds, and of course have probably no bleeding season, as is the case with those of the deciduous kind.

And there is another circumstance which has been stated by Dr. Milae, in his botanical dictionary, to take place in respect to evergreen trees, which is, that when they are engrafted on those of the deciduous sort, it determines the latter to retain their leaves. This is asserted to be confirmed by repeated experience, in grafting the laurel, (*lauro-cerasus*) an evergreen, on the common cherry, (*cerasus*), and the (*ilex*), an evergreen oak, on the common oak. And it is probable that many other facts of the same kind may exist, though they have not been noticed by common gardeners.

EVERLASTING. See GNAPHALIUM.

EVERLASTING Pea. See LATHYRUS.

EVERLASTING Pea, in *Agriculture*, is the common name of a perennial plant of the vetch kind, which grows naturally in some situations in this country; and is capable of being cultivated with great care and advantage as a green food for cattle or other stock, where the soils are inclined to be of the more heavy loamy kinds; as it affords a large produce of the most nutritious sort of fodder. Where it is suffered to stand till the seeds are formed, it has been found in the few trials that have been made with it to possess a highly fattening property when consumed by animals.

EVERRIATOR, derived from *ex* and *verro*, *I cleanse*, in *Antiquity*, an officer who was obliged in a solemn manner to cleanse such houses as were defiled by dead bodies, called *domus funestæ*.

EVERRICULUM, (from *everro*, to sweep away,) a kind of instrument, in *Surgery*, resembling a spoon, and used for taking away any small fragments of the stone, which may remain behind in the bladder, in the operation of lithotomy.

EVERS, in *Rural Economy*, a term sometimes provincially applied to those stiles which open; in which case the top rail has a bolt of iron driven through it at one end, the other falling into a notch in the opposite post, by which contrivance an opening can occasionally be readily made.

EVERSBERG, in *Geography*, a town of Germany, in the kingdom of Westphalia; 34 miles N. of Cologne.

EVERY YEAR'S LAND, in *Agriculture*, is a term applied to such lands as have been cropped with what are termed brown and white crops, or pulse and grain crops, in alternation or succession for a very great length of time, without the intervention of any sort of fallow. Mr. Marshall has remarked that extensive common fields in Gloucestershire have been conducted under this sort of management for "perhaps centuries;" and the same is the case in some other countries.

EVES-DROPPERS, in *Law*. See EAVES-DROPPERS.

EVESHAM, or ESAM, in *Geography*, is a borough and market town, pleasantly situated upon a rising ground, above the banks of a navigable river, named the Warwickshire Avon, in the hundred of Blakenhurst, and county of Worcester, distant from London ninety-six miles. This place claims high antiquity, and is not less notable for its subsequent celebrity. The first notice of it upon record, like the origin of most towns referable to the Saxon period, is the account of Egwin, bishop of Worcester, having founded a monastery here in the year 709; and amply endowed it by the assistance of Kenred, son of Wulpher, king of Mercia. This was one of the mitred abbies; its abbot

## E V E S H A M.

fat in the house of peers as a baron of the realm; its privileges were numerous and extensive, and the revenues on the dissolution were valued at the annual sum of 1183*l*. Of the building, which from records appears to have been immense, few vestiges remain. The large elliptical arch, decorated with rich but mutilated imagery, is still standing; and the tower noticed by Leland. "Clement Lichfield the last abbot of Evesham gave one, did very much cost in building of the abbey and other places longing to it.—He made a right sumptuous and high square tower of stone in the cemetery of Evesham. This tower had a great bell in it, and a goodly clocke, and was as a gateway to one piece of the abbey." Itinerary, vol. iv. p. 108. This tower is a regular and beautiful structure, twenty-two feet by twenty-two, and one hundred and seventeen in height; and is generally considered the last monastic building erected under papal influence in England. Though the churches have towers, this still continues the station for the clock and bells.

In that part of the town called Bengeworth, which may be viewed as a suburb on the eastern side of the river, over which the communication is formed by a handsome stone bridge of seven arches, stood an ancient castle, probably erected soon after the Norman conquest. For in the year 1152, abbot William de Audville gained this fortress from lord William de Beauchamp, who held it for king Stephen, razed it level with the ground, and converted the site into a place of interment.

Evesham is a very ancient borough, enjoying numerous privileges, both by prescription and charter. It was one of the towns summoned by writ to send members to parliament, in the twenty-third year of king Edward the First's reign, when he basely pretended to restore the Saxon constitution; and was one of the eight boroughs which had their elective franchise restored in the time of James the First. That monarch at the same time granted a charter to the town to be governed by a mayor, seven aldermen, twelve burgesses, and twenty-four assistants, recorder, chamberlain, who are also of the common council, and other subordinate officers. The mayor and four senior aldermen are justices of the peace, form a *quorum*, and have power to hold a sessions of *oyer* and *terminer*, and gaol delivery, to punish all crimes, except high treason, and execute felons within their liberty.

The town is much altered since Leland visited it; the houses, which then were what are called *half-timbered*, that is, timber frames, having the open parts filled up with wattle and dab, are mostly well built with brick, the streets are wide and spacious, and the salubrity of the air, with the beauty of the situation, induce many genteel families to take up their residence here. In the town are three parish churches, two in the part usually called Evesham, and one in Bengeworth; a well endowed free grammar school, charity school, and alms-house. The market, held on Mondays, is well supplied, and four annual fairs are held February the second, the first Monday after Easter, Whit-Monday, and the twenty-first of September. From the late returns to government under the Population act, the number of houses appear to be 616, and of inhabitants 2837. The richness of the soil in the vicinity has been long an inducement to turn many of the fields into garden ground, and the peculiar fineness of the vegetable productions of this place has rendered Evesham gardeners proverbial for unrivalled skill. They not only supply the neighbourhood, but also the city of Worcester, fourteen miles distant; Birmingham, thirty; and during the asparagus season Bath and Bristol, more than fifty. Tindal's History and Antiquities of Evesham.

**E V E S H A M, Vale of.** The finest tract of land comprized under this denomination, unrivalled in fame or fertility, is situated on the eastern and western banks of the river Avon, extending for several miles in various directions into Warwickshire, where it is bounded by the high land of the Ridgeway, and into Gloucestershire, where the Cotswold hills form a terminating barrier; and the south is washed by the river Severn.

It is described in Monastic history as having derived the name, which it gives to the town already described, from *Eoves*, a Saxon, a wine-herd to Egwin bishop of Worcester, in the latter end of the seventh century: this ham having been Egwin's property till he was dethroned by the pope, and his estates confiscated. Previously to this it was called *Heth-holme*, or *Heath-field*.

To those who wish to see what "sun and soil," unassisted by art, can do, parts of this district will furnish striking specimens. And to the admirers of agriculture other portions will evince what wonders may be effected from aiding the efforts of nature by the application of art. The soil is principally a deep heavy loam, or rich loamy clay, of inexhaustible depth, equally calculated for corn, or pasturage. And whether it be placed under an arable, or a grazing system, the produce and the profits alike exceed analogical belief. The vale of Evesham, says Leland, "is, as it were, for such an angle, the horreum of Worcestershire, it is so plentiful of corn;" and justly has he characterized this prolific spot. For the abundance of herbage is not equalled by the famous Tilney meeth in the hundred of Marshland and county of Norfolk; nor can the crops of corn be surpassed, except by those described in Brydone's Tour as produced in the vales of Sicily. The rent of lands in the farms of this district is equal to that of accommodation lands in most other parts of the kingdom; yet persons who have occupied estates in some others, at an exceeding low rate on a comparison of the net proceeds from both, do not hesitate in deciding in favour of the higher rental. In this vale, about a mile distant from the town of Evesham, was fought the most memorable battle recorded in the annals of English history, between Simon de Montfort, the powerful earl of Leicester, and prince Edward, afterward king Edward the First; in which the earl was completely defeated, and the refractory barons, with most of their adherents, taken or slain. He has been not unaptly compared to the Roman conspirator Catiline, for, like him, he verified in his conduct the remark of Tiberius, recorded in Tacitus Ann. l. iv. c. 18. "Beneficia eo usque lata sunt, dum videntur exsolvi posse." "Favours are only so long properly bestowed as there appears a probability, or at least a capability of return." After king Henry the Third had conferred upon him an accumulation of honours and emoluments, and even permitted him to marry the princess, his sister; he experienced from the earl the most ungrateful requital. He pursued the monarch with the most inveterate hatred; and by inflammatory speeches, and other overt acts, excited the most perplexing commotions, and distressing intestine warfare, the kingdom ever experienced; under a pretence of restraining the prerogative, reforming the government, and ascertaining and securing the liberties of the subject. The contest, however, was productive of good, intended by neither of the parties. The prince, when he had ascended the throne, determined to still further curtail the enormous power of the barons; and by his writs summoned together, as his advisers, representatives from numerous cities and boroughs, as well as counties; the battle of Evesham therefore may be considered "as the origin of our present house of commons."

**E V E S H A M**, a township of America, in Burlington county, New

New Jersey, situated between the forks of Moore's creek, which runs north-westerly to Delaware-river; 16 miles E. of Philadelphia.

**EVESPERIDES**, in *Ancient Geography*, a people of Africa, in the maritime part of Libya, to the west of the Aufchifes: whose country, according to Herodotus, was singularly fertile; whence it has been supposed that the famous garden of the Hesperides was found in their territory. This name, in its grammatical acceptation, signifies Occidentals.

**EVESPERIS**, a town on the coast of Africa, which afterwards took the name of Berenice.

**EVEST**, in *Geography*, a river of Russia, which runs into the Dwina, near Kreutzburg.

**EUEXIA**, from *eu*, well, and *εξω*, habit, in *Medicine*, a good sound habit of body.

**EUFEMIA**, **ST.**, in *Geography*, a town of Naples, in the province of Otranto, two miles N.N.E. of Alessano.—Also, a town of Naples, in Calabria Ultra, situated on a bay of the Mediterranean, to which it gives name. N. lat. 39° 2'. E. long. 16° 30'.

**EUFRA**, a town of South Finland; 12 miles N.N.E. of Abo.

**EUGALENUS**, **SEVERINUS**, in *Biography*, a physician of Doccum, in Friesland, known chiefly as the author of a treatise on the scurvy, which once maintained a considerable character, and passed through many editions. Its title is "De Scorbuto Liber, cum Observationibus quibusdam, brevique et succinctâ cujusque curationis indicatione, 1604." But the treatise of Dr. Lind, on the same subject, in which the absurdities and ignorance of Eugalenus are pointed out, has superseded it. Eloy. Mangeti Bibl. Script. Med.

**EUGANEI**, in *Ancient Geography*, a people of Italy, towards the Alps.

**EUGANO**, in *Geography*, a mountain of Italy, in the west part of the Paduan, bordering on the Vicentin.

**EUGENE**, **FRANCIS**, of Savoy, in *Biography*, generally denominated prince Eugene, grandson of Charles-Emanuel, duke of Savoy, was born at Paris in 1663, and destined for the church. His mother, on account of her ill-conduct, was obliged to leave Paris. She retired to Brussels, and young Eugene being deprived of her support, and having been disappointed in his expectations of preferment, went as volunteer to serve in Germany against the Turks. He, with other French volunteers, was recalled on pain, in case of disobedience, of perpetual banishment. He set the order at defiance, and so much distinguished himself in his first campaign, that the emperor gave him a regiment. After the siege of Vienna was raised, he served in Hungary under the command of the duke of Lorraine and the elector of Bavaria. From this time his reputation increased, with every action in which he engaged, till, in the year 1697, he was appointed to the command of the imperial army. In the autumn of this year he entirely defeated the Turks at the battle of Zenta, in which the grand vizier and more than 20,000 men were left on the field, and the grand seignior was obliged to make a precipitate retreat with the broken relics of his army. Eugene had hazarded this engagement contrary to the express orders of the imperial court; but he so completely justified his conduct, that Leopold gave him a written authority to act thenceforth according to his own judgment. He was now opposed by all the great French generals, but in every battle his exertions and prowess were crowned with success, and on returning to Vienna the emperor created him president of the council of war, and entrusted the military chest to him; but that chest was

frequently ill supplied, which occasioned him more trouble than the most vigorous opposition in the field. He was strictly united with the duke of Marlborough, and by their talents and concert they obtained a decisive superiority over the French in Germany. At the celebrated battle of Blenheim, Eugene commanded the imperial part of the army; and had no small share in the success. In 1705, he was defeated in Italy, but in the following campaign he regained his reputation by marching across Lombardy in the face of the French army, and attacking the French in their intrenchments at Turin, over whom he obtained a complete victory, which secured the duke of Savoy and restored all the Milanese to the emperor. In 1707, he invaded France, but without obtaining any decisive advantage, and in 1708 he was with the duke of Marlborough at the battle of Oudenard, and the capture of Lisle. He commanded the centre at the bloody battle of Malplaquet, where he was grievously wounded, but refused to retire from the field, saying, "Of what use will it be if we are to die here;—if we are to survive it will be time enough in the evening to be dressed." When the politics of England took a turn and peace was determined on, Eugene carried on the war alone, till it was concluded by the peace of Radstadt in 1714. Shortly after this he was called on to contend again with the Turks, whom he signally defeated in the year 1716. In the following year he undertook the siege of Belgrade, when the Turks came to its relief, and invested him in his camp. He suffered them to approach very near, and then suddenly quitting his lines fell upon them with so much vigour, that he killed 20,000 men, and possessed himself of their cannon and camp equipage. Belgrade immediately surrendered, and an advantageous peace was the result of this important victory. Eugene now retired to Vienna covered with glory, and justly considered as the saviour of the empire, and the greatest benefactor to the house of Austria: He was great in retirement, as he had been heroic and magnanimous in war. In the year 1733 he attempted new exploits, in consequence of the disputed election to the Polish crown; but he was no longer the great, the enterprising Eugene. He died in 1736 at Vienna, aged seventy-three. As a man he was cold and reserved in his manner, and serious in his aspect: as a friend he was liberal, free from pride, faithful to his promises, and ever ready to do a kind action. As a general he was regarded by those under him in the character of a father and protector: in his military capacity he was enterprising, full of resources, and though he sometimes committed faults, he rarely failed to redeem his credit by new and brilliant successes. Moreri. Modern Universal Hist. Hist. of England. See also the article **CHURCHILL** in this Dictionary.

**EUGENIA**, in *Botany*, so named by Micheli in compliment to the heroic prince Eugene of Savoy, who sent him from Germany almost all the plants described by Clusius, and who had a celebrated botanic garden. Mich. Gen. 226. t. 108. Linn. Gen. 247. Sm. Tr. of Linn. Soc. v. 3. 280. Schreb. 333. Willd. Sp. Pl. v. 2. 959. Mart. Mill. Dict. v. 2. Juss. 324. (Syzygium; Gærtn. t. 33.). Class and order, *Icosandria Monogynia*. Nat. Ord. *Hesperideæ*, Linn. *Myrti*, Juss.

Gen. Ch. Cal. Perianth superior, in four deep, oblong, obtuse, concave, permanent segments, the orbicular centre between them elevated, and somewhat downy. Cor. Petals four, twice as large as the segments of the calyx, oblong or roundish, obtuse, concave. Stam. Filaments numerous, inserted into the elevated ring of the calyx, about as long as the corolla; anthers small, roundish. Pist. Germen inferior, turbinate; style simple, the length of the stamens; stigma

stigma simple: *Peric.* Berry roundish or angular, crowned with the calyx, of one cell. *Seed* solitary, roundish, smooth and even.

*Eff. Ch.* Calyx superior, in four deep segments. Petals four. Berry of one cell, with one seed.

*Obf.* The number of petals, and segments of the calyx, is frequently five, in one instance eight. The germen has, in some species at least, two cells, though one of them becomes obliterated as the fruit ripens.

This is an extensive genus, chiefly from the East and West Indies, whose species are as difficult to define as the roses in our European gardens. Their habit is akin to the myrtle, but often more stout and arborefcient. *Leaves* simple, opposite, ovate or elliptical, entire, without stipulas, most frequently smooth, paler beneath, evergreen. *Flowers* either terminal or axillary, white or reddish. *Fruit* not unwholesome, but scarcely ever very grateful to the palate; in some cases highly fragrant. Willdenow has 30 species, a number far short of what are known, and yet two of them (*acutangula* and *racemosa*), are scarcely true *Eugenia*. There is also some confusion between this genus and *Plinia*, the original *E. uniflora*, Linn. Sp. Pl. 673, being not only *Myrtus brasiliensis*, *ibid.* 674, but also *Plinia rubra*, Linn. Mant. 243; as well as *P. pedunculata*, Linn. Suppl. 253; under which last name it is figured in Curt. Mag. t. 473, with a wrong quotation of Linn. Mant. Whatever the *Plinia* of Plumier may be, this plant is the original *Eugenia* of Micheli's figure, and is well known in the Brasils and West Indies, its fruit resembling an indifferent cherry in size, taste, and colour, though different in being externally furrowed. This fruit sometimes ripens in stores in England, but the plant is no general favourite, being a meagre representative of the common myrtle.

*E. Jambos.* Linn. Sp. Pl. 672. (Malacca Schambu; Rheede Hort. Mal. v. 1. t. 17.), is much celebrated for the fragrance of its fruit, which resembles that of a rose, or rather rose-water. It is also of an extremely fine yellowish colour with a rosy tint, and though not pleasant to the taste, is frequently brought to table in the Indies, for the sake of its perfume.

*E. malaccensis.* Linn. Sp. Pl. 672. Sm. Exot. Bot. t. 61, a beautiful East Indian species, is esteemed for the elegance of its red clustered flowers, as well as the flavour and cooling quality of its fruit.

**EUGENIUS I.** in *Biography*, pope, was born at Rome, and raised to the highest dignity in the church in the year 634, on the deposition of pope Martin. He owed his elevation to the choice of the Roman people and clergy, and their choice was confirmed by the emperor Constans. At this period the western and eastern churches were furiously contending with each other upon the question whether Christ possessed one will or two. Eugenius, after his promotion, took pains to quiet the minds of the disputants. A compromise was entered into between the parties, but it was not of that nature to command general approbation: it was unsatisfactory to the Roman people and clergy, who opposed the admission of the patriarch Peter's confession of faith. Peter had taken the other side of the question, and in his confession he took no notice of the will and operations in Christ. So vehement was this party that they refused to permit the pope to perform divine service in the church of St. Mary, until he had publicly declared his condemnation of it. We have no other particulars relating to this pope, who died in the year 657, but he was commended by his contemporaries and successors for piety, mildness, humanity, and generosity. Moreri. Bower.

**EUGENIUS II.** pope, was a Roman by birth, and

from being archpriest of St. Sabina, was made bishop of Rome in the year 824. This election was opposed by the people, who made choice of a different person for pope. The double election excited considerable disturbances at Rome, which occasioned the interference of Lewis the Debonnaire, who decided for Eugenius, and confirmed him in his high office. The monarch took this opportunity of reviving several ancient customs and laws, declaratory of the dependence of the bishops of Rome on the imperial power, and determining the limits of the submission and obedience which were paid to them. Eugenius, to secure his own power, took the oath of fidelity to Lewis and his son Lotharius, in which was included their solemn engagement that no future pope should be consecrated with their consent, but in the presence of the emperor's deputy, and after the exaction of a similar oath to what was at that time administered. During the pontificate of Eugenius, a council was assembled in France under the auspices of Lewis and the Greek emperors Michael and his son Theophilus, to examine the doctrine of the Greek church, in relation to images. This was in the year 825, and at the conclusion of the council the bishops wrote a letter to Lewis, giving sentence against both parties, *viz.* the churches of Constantinople and Rome; the former for breaking images, whence they were denominated "Iconoclastæ," and the latter for worshipping them, whence they obtained the title of "Iconolatæ," declaring at the same time that it was a far greater crime to worship than to break images. The emperor was also exhorted by the council to interfere with the pope, and to intreat him to abolish the superstitious worship of images, which was the cause of much offence to all good men. Lewis wrote to the pope, and deputed two bishops to reason with him on the subject, but to little or no purpose; he continued not only to promote, but to justify the practice of image worship. In the following year Eugenius held a council at Rome, in which a number of decrees were passed, intended to reform the state of ecclesiastical discipline, and to encourage the progress of literature both sacred and profane, but he died in the year 827, before he could carry his plans into effect. He was highly spoken of by Catholic writers, and applauded for his humility, his beneficence, and the humane policy of his government. He is represented as excelling in mental and corporeal endowments. As a writer, two of his epistles, and eleven of his decrees, are extant in the seventh volume of the "Collectio Conciliorum." It has been reported, and not greatly to the credit of Eugenius, that he was the institutor of the ordeal by cold water. See ORDEAL. Moreri. Bower.

**EUGENIUS III.** pope, so called upon his elevation to the popedom, from his usual name Bernard, was a native of Pifa, and a disciple of St. Bernard. On the death of Lucius II. in the year 1145, Bernard was unanimously fixed on by the cardinals as the new pope, and was enthroned with the usual ceremony under the title of Eugenius III. The people, who had been long struggling to wrest from the popes the sovereignty which they had acquired over them in temporal matters, would not suffer Eugenius to be consecrated, unless he resigned all pretensions to dominion, otherwise than as connected with his spiritual rank, and would be contented with the revenue to be derived from tithes, and the voluntary contributions of the faithful. Unwilling to make these concessions, he privately withdrew to the Benedictine monastery of Farfa in Sabina, whither he was followed by the cardinals, and consecrated. Not daring to return to Rome, he removed from Farfa to Viterbo, where he continued for some months. During his abode there ambassadors arrived from the Crusaders in the East, to im-  
plore

## EUGENIUS.

plore assistance from the pope and the western princes against the Turks, who had gained some important advantages over them. Eugenius supplicated the assistance of Lewis VII. king of France, strongly urging him to march in person to the relief of the Christians in the Holy Land, and conferring on those who should attend him the privileges which his predecessors had granted to such as engaged in the holy war. Lewis embarked, and Eugenius now took measures to reduce the Romans to submission, which he effected in a short time, and forced them to acknowledge him as their temporal as well as spiritual lord. His triumph was of no long duration, for an insurrection obliged him to seek for personal safety in flight. He went to Treves, where he held a council in the year 1146. In the following year he was respectfully entertained at Paris by the king; and here he was allowed to hold a council, in which William, archbishop of York, was deposed from his dignity. From Paris he went to Rheims, where, in 1148, he held that council before which the fanatic Eon was examined. See EON. He next returned to Italy, and, with the assistance of the king of Sicily, once more subdued the people of Rome, in the year 1149. Shortly after this he was obliged to retire into Campania, where he remained till the year 1152. During this period he was not inactive, but sent a legate into Ireland, by whom he established the four archbishoprics in that kingdom. He was now permitted to return to Rome, where he lived in peace till his death in 1153. His virtues have been highly commended by his contemporaries. By some writers his chief merit arises from his zeal and sufferings in promoting the interests of the holy see, and in combating the errors of heretics: by more modern historians his memory has been held in abhorrence on account of the active part which he took in promoting the Crusades, by which great calamities overwhelmed Europe and the eastern world. Moreri. Bower. See CROSSADE.

EUGENIUS IV. pope, was a native of Venice, and of plebeian rank, though descended from an ancient family. His original name was Gabriel Condelmerio, and while he was very young he accompanied a nephew of pope Gregory XII. to Rome, where he took the Celestine habit. He was afterwards made treasurer to the pope himself, and then bishop of Sienna. In 1408 he was advanced to the office of cardinal presbyter of St. Clement. While Martin V. was pope he was sent delegate into the Marche of Ancona, and afterwards to Bologna, and performed the duties reposed in him with great ability and reputation. On the death of Martin in 1431, he was elected to the papal see, when he assumed the name of Eugenius IV. Immediately upon his elevation he involved himself, and the city of Rome, in the most alarming difficulties, by attempting to seize upon treasures said to have been left by his predecessors; and no sooner was he extricated from the dangers resulting from this conduct, than he drew upon himself fresh troubles with the council of Basil, which he determined to dissolve on account of their conciliating measures with the Hussites of Bohemia. His legate, cardinal Cæsarini, whom he empowered to act on the occasion, a man of much discretion, forewarned him of the troubles he was likely to bring on himself by the act. Eugenius had, however, made up his mind, and in 1431 issued his bull, declaring the council of Basil to be dissolved, and appointing another to be convened in eighteen months at Bologna. The emperor urged the pontiff to revoke his decree, setting forth in strong and very pressing terms the evils into which he would otherwise plunge the Christian world; and he added that he was sure the assembled bishops would not submit to be disappointed

of the object of their meeting, and that he, as protector of the church, was bound to afford them his support. Eugenius was immovable, and the council were alike determined to set his power at defiance. After confirming the decrees of the council of Constance, which declared the papal power to be subordinate to that of a general council, and bound by its statutes and mandates, they voted that no power on earth could dissolve them without their consent, and that none should withdraw from them without their leave; and they went so far as to summon the pope to appear in person before them within a limited time, or to send legates with full authority to act in his name. The firmness of the council, after much altercation, brought the pope to submission, and in the year 1433 he issued a bull, declaring null and void whatever had been done by him, or in his name, in derogation of the council-general of Basil. In the same year Eugenius received the emperor Sigismund at Rome with great magnificence, and crowned him there. Shortly after this he was attacked by Philip duke of Milan, who laid waste the territory of Rome, and when the inhabitants laid their complaints before the pope, he referred them to the cardinal his nephew, who, regardless of every thing that did not contribute to his own ease and pleasure, treated their sufferings with neglect and contempt. Enraged at this behaviour they took up arms, and produced a temporary revolution at Rome. It was with the utmost difficulty that Eugenius escaped from their fury, and took refuge at Florence; a reconciliation was effected, which was farther confirmed through the mediation of the council of Basil, who dispatched some of their body to offer friendly advice on the occasion. In 1437 fresh dissensions arose between the council and the pope, which terminated in their final rupture, and a new council was appointed to meet at Ferrara, whose first act was to declare the congregation of Basil an unlawful assembly, and themselves the only oecumenical council lawfully assembled, and they ordered all bishops who still remained at Basil to withdraw from that city within thirty days, on pain of excommunication, and the forfeiture of their dignities and benefices. The council of Basil, on the other hand, passed a decree or sentence of suspension against Eugenius from papal jurisdiction, forbidding all ecclesiastics, on pain of excommunication, to obey him. Early in the year 1439, a contagious disorder breaking out at Ferrara, the pope translated the council to Florence, where a pretended union was effected between the Greek and Latin churches, which, being violently opposed at Constantinople, was rendered null and void. In the mean time the council of Basil, after declaring the superiority of councils over the pope to be an article of the Catholic faith, proceeded to depose Eugenius from the papacy, as disobedient to the commands of the church, a contemner of the canons, a disturber of the unity of the church, and an obstinate heretic; and they dispatched nuncios to the different courts of the Christian princes to acquaint them with the measures which had been adopted. Eugenius thundered out his excommunications against the fathers at Basil, but they held his decrees in derision, and raised to the papal throne Amadeus, duke of Savoy, who assumed the name of Felix V. The rival popes and rival councils anathematized each other, laying claim to the true apostolic powers. Eugenius was supported by France, Italy, Spain, Portugal, Hungary, and England, but Felix was defended by the people of Savoy, by the Swiss, and by the dukes of Bavaria and Austria. The German princes chose to preserve a neutrality till the year 1447, when they declared for Eugenius, determining that he was the only true vicar of Christ upon earth. In the midst of the public rejoicings on this occasion, he died in his

his sixty-fourth year. His character as a pope is easily gathered from what has been said; he was ambitious, intriguing, and a decided enemy to reform. In his last illness he is said to have been painfully affected with reflections on his past life; "Oh Gabriel," exclaimed the dying pontiff, "how much better had it been for thy soul's safety, hadst thou never been promoted to the dignity of cardinal or pope!" He was a patron of literature and learned men, though he had no pretensions to learning himself; his epistles and bulls are to be found in volumes xii. and xiii. of the "Collectio Conciliorum." He was a handsome man, of a venerable aspect, and always looked downwards when he appeared in public. He was frugal and temperate in his own person, but was liberal and hospitable; and at his table there was a princely magnificence. In this reign the cardinals began to indulge in the sports of the field, and to abandon themselves to all kinds of luxury. Bayle. Moreri. Bower.

EUGENIUS, Catholic bishop of Carthage, was raised to that situation in the year 481, at the request of the emperor Zeno, who had entered into a treaty of peace with Hunneric, at that time the reigning monarch. In the year 483, he was summoned, with the other Catholic bishops, by the king, to Carthage, to maintain a public debate in defence of their principles against the Arian bishops, whom he patronized. Eugenius undertook to draw up a treatise, explanatory of the Catholic faith, which was approved by all the bishops of his party, and presented to Hunneric, and he offered to defend the principles contained in it by an appeal to the sacred writings, as well as to the sentiments of the fathers. He also delivered a petition to that prince, in the form of an apology, the design of which was, to obtain peace for the Catholics. It was, however, of no avail; the bishops of that party were all sentenced to banishment, and Eugenius was sent into exile, amidst the dreary deserts of Tripoli. In the following year Hunneric died, and Eugenius was permitted to return to Carthage, but was again banished, on the accession of Thrasamund, and sent into Gaul. He died at Albi, in the year 505. His principal works are, "Expositio fidei Catholicæ," "Apologeticus pro fide;" "Altercatio cum Arianis;" and a letter to his people, exhorting them to constancy in the orthodox faith. Moreri.

EUGENIUS, bishop of Toledo, in the seventh century, was attached to the monastic life, but compelled, by order of the prince, to accept of the episcopal dignity in the year 646. He filled that see several years, and made a figure at the councils of Toledo, which were held in the years 653, 655, 656. He was author of a treatise "On the Trinity," and two books on miscellaneous subjects. He revised and improved Dracontius's work on the creation of the world, which was published at Paris, together with his "Opuscula," in the year 1619. Moreri.

EUGHTGUR, in *Geography*, a town of Hindoostan, in the circar of Kitchwara; 15 miles E. of Ougein.

EUGIA, in *Ancient Geography*, a small country of the Peloponnesus, in Arcadia.

EUGMO, in *Geography*, a small island on the east side of the gulf of Bothnia. N. lat. 63° 49'. W. long. 22° 42'.

EUGUBIO. See GUBBIO.

EUHYDRIUM, in *Ancient Geography*, a town of Greece, in Thessaly, according to Livy.

EVIAN, in *Geography*, a town of France, in the department of the Lemane, on the coast of the lake of Geneva, containing two parishes and two convents. The place includes 1502, and the canton 12,911 inhabitants, on a territory of 280 kilometres, and in 19 communes.

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Near Evian are some mineral waters, which render it in summer a place of resort. It is situated 23 miles N. E. from Geneva. N. lat. 46° 25'. E. long. 6° 24'.

EVICTION, from *evincere*, *I overcome*, in *Law*, signifies a recovery of lands or tenements by law.

EVIDENCE, a quality in things whereby they become visible and apparent to the eyes, either of the body or the mind.

The schoolmen distinguish evidence into *formal* and *objective*. The former is the act of the intellect, considered as clear and distinct; the latter consists in the clearness and perspicuity of the object; or it is the object itself so constituted as that it may be clearly and distinctly known.

Others divide evidence into *moral*, *physical*, and *metaphysical*. A thing is said to be *morally evident*, so far as we have a distinct notion or knowledge thereof, by unexceptionable witnesses; *physically*, so far as natural sense and reason, pointing out any thing, convince us thereof; *metaphysically*, when we enter fully and clearly into the essence of any thing.

Evidence is the essential and infallible character or criterion of truth, and is that in effect which with us constitutes truth.

If evidence should be found in propositions that are false, we should be compelled into error, since the assent we give to evidence is necessary: whence would follow this impious position, that God who made us is the author of our errors, as he has constituted us so as to put us under a necessity of falling into them.

It may be added that as we necessarily love truth and hate error, it seems inconsistent with the nature of a beneficent being to form us with a love of what we could not obtain, or not know whether we did obtain it or not; besides, that if we should err in things that are evident, as well as in those that are not so, we should sometimes find contradictions in evident propositions, as we commonly do in things that are obscure.

Evidence, therefore, must be allowed the mark of truth; and those things must be allowed true which carry with them such a degree of evidence as obliges us to assent to them. Whatever we see evidently agreeable to things whereof we speak, that we must acknowledge to be true.

The Epicureans allow of no other evidence but that of sense, or that arising from sense, it being a fundamental principle with them, that sense is the first and primary criterion of all truth. By evidence of sense, they mean that species or image exhibited by the sense or phantasy; which, when all impediments to a just judging, as distance, motion, medium, &c. are removed, cannot be contradicted or gainsaid; wherefore, the question being put, whether or not a thing be such as it appears; the answer is not to be given, till it has been tried and examined in all the ways, and by all the senses, of which it can be an object. See ERROR.

There are certainly other superior and less fallible sources or grounds of evidence than sense: such is that inward consciousness by which we learn what belongs to the mind, or that which Mr. Locke calls reflection; of which such are intelligence, intuition, and common sense, principally relating to those abstracted, or other propositions that carry their own evidence with them, and admit no doubt about them; whence we derive our assent to propositions called axioms and maxims: such is also reasoning, whereby we infer one truth from others by natural and just methods of argument, whence results science: such is likewise the testimony of others, on which we found the evidence of FAITH (see also TESTIMONY): to which we may also add

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inspiration, or that impresson made on the mind by God himself, which gives a convincing and indubitable evidence of the truth of any proposition, and attested to others, either by prophecy or miracles. Watts's Logic, part ii. chap. ii. § 9.

By thus considering the various sources whence our perception and belief of any truth are derived, we may be led to distinguish evidence into intuitive and deductive, and that founded on testimony. Intuitive evidence comprehends that of pure intellection, of consciousness, and of common sense, under the last of which that of memory is included. (See INTUITIVE.) Deductive evidence is divided into scientific and moral; the latter of which includes those kinds of evidence that are deduced from experience, analogy, and testimony, to which may be added a mixed species, derived from the calculation of chances. (See DEDUCTIVE.) See also each of the above-mentioned subjects. See Campbell's Phil. of Rhet. book i. chap. 5.

The evidences of the Christian religion are distinguished into two kinds, the direct and collateral: the direct evidences are external and internal; the external are miracles and prophecy; the internal evidence is deduced from its excellence, considered in reference to the main and principal end of Christianity. Whatever does not either belong to its excellence considered in this light, or fall under the head of miracles wrought on purpose to attest it, or of prophecies fulfilled, and yet affords a proof or any real presumption of its truth and divinity, is a collateral evidence for it. All the collateral evidences of the truth of Christianity are in one sense internal evidences, because they all arise from some particulars in the nature of this religion, from some circumstances which have attended its reception, or sprung from it, or from some remarkable facts connected with it, and related in the gospel history. Of this kind is the argument deduced from its great efficacy at its first appearance, in banishing polytheism, idolatry, superstition, and the arts of magic; in softening the rigour of despotism, introducing moderation into government, excluding many inconvenient civil laws once generally prevalent, giving rise to others of a very happy tendency, resisting the laws of war, humanizing the manners, and improving the customs of nations, and reforming the temper and conduct of those who embraced it.

Another class of collateral arguments for the truth of the Christian religion, arises from particulars in its nature or effects produced by it, or from facts in the Gospel history, which cannot be at all accounted for but on the supposition of a Divine original; or which are, at least, most naturally explicable on that supposition. To this class may be referred those presumptive arguments deduced from the character of Jesus, so exalted, and yet so uniformly supported; the nature of his last discourses with his disciples; the character of some of his apostles; that of Judas the traitor; the controversies among Christians in the apostolic age; and the method used by Christ and his apostles, of referring their claims to the impartial inquiries of men. Other collateral arguments have an affinity to the external evidences of Christianity: such are those derived from the miraculous conversion of the apostle Paul and his subsequent conduct; from the character of the man of sin foretold by Paul; from the quick and extensive propagation of the Gospel; from the continuance and present state of the nation of the Jews. Some of these arguments have an immediate relation to the proof of Christianity from prophecies; others are related to the proof from miracles. Other arguments have an equal relation to the internal and external evidence of Christianity; such

is that deduced from the manner in which Christ and his apostles proposed the evidences of their mission, and the advantage they have gained in consequence of the opposition and scrutiny of unbelievers. See on this subject Lord Lyttelton's Observations on the Conversion and Apostleship of St. Paul, Duchal's Presumptive Arguments for the Truth of the Christian Religion, and Gerrard's Dissertation on the genius and evidences of Christianity.

EVIDENCE, in Law, is any proof, whether by testimony of men on oath, or by writings and records; the former called *parol evidence*, that is, by word of mouth, and the latter *written evidence*.

It is thus called, because the point in issue is hereby made evident to the jury. Evidence in the trial by jury includes not only that which is given in proof, but that which the jury may receive by their own private knowledge; for an account of which see the sequel of this article.

With regard to parol evidence, or witnesses, we may observe in general, that all witnesses, whatever be their religion or country, that have the use of their reason, are to be received and examined, except such as are *infamous*, or such as are *interested* in the event of the cause. All others are competent witnesses; though the jury from other circumstances will judge of their credibility. Infamous persons are such as may be challenged as jurors, *propter delictum*; and, therefore, never shall be admitted to give evidence to inform that jury, with whom they were too scandalous to associate. Interested witnesses may be examined upon a *voir dire*, if suspected to be secretly concerned in the event; or their interest may be proved in court. A party interested in a suit, or a wife for or against her husband, a husband against his wife, except in cases of treason, an alien infidel, persons *non sana memorie*, those that are attainted of conspiracy, or in a *præmunire* upon stat. 5 Eliz. cap. 1. popish recusants convicted on stat. 3 Jac. I. cap. 5. (See contra 1 Hawk. P. C. c. 12. § 6.) persons convicted of felony, perjury, &c. those who by judgment have stood on the pillory, or been whipped, whilst the judgment is in force, are disabled from giving evidence: but kinsmen, though ever so near, tenants, servants, maisters, attornies for their clients, but not against them, because they are obliged to keep their secrets, one of the jurors upon trial, and all others that are not infamous, who want not understanding, or are no parties in interest, may give evidence in a cause, though the credit of servants is left to the jury. (2 Rol. Abr. 685. 1 Vent. 243.) If after a man hath stood in the pillory, &c. he be pardoned, he may be an evidence; and though judgment of the pillory infers infamy at common law, by the civil and canon law it imports no infamy, unless the cause for which the person was convicted was infamous; and, therefore, such may be a good witness to a will, if not convicted of any infamous act. (3 Lev. 426, 427.) It has been held, that it is not standing in the pillory which disables a person for giving evidence; but standing there upon a judgment for an infamous crime, as forgery, &c. If for a libel, a man may be a witness. (5 Mod. 74. 3 Nels. Abr. 557.) Persons excommunicated cannot be witnesses; but persons outlawed may be witnesses, because the outlawry has no influence on their credibility. (Bull. N. P. 292, 3.) A man convicted of felony, and afterwards pardoned, may be a good evidence. (Raym. 369.) Burning in the hand is said to restore a person to his credit. (Ibid. 330.) A person condemned to be hanged for burglary, but having a pardon for transportation, hath been allowed to be a good evidence. (5 Mod. 108.) One outlawed for treason and pardoned may be an evidence. (State Trials, vol. iii. 515.) Persons acquitted, or guilty of the same

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same crime, while they remain unconvicted, may be evidence against their fellows. (Kel. 17.) Although no evidence ought to be given of what an accomplice hath said, who is not in the same indictment; (State Trials, vol. ii. 414.) an informer may be a witness, though he is to have part of the forfeiture, where no other witnesses can be had. (Wood's Instit. 598.) If an action is brought against many persons for taking of goods, one of them may be admitted as an evidence against the rest. (Comberb. 367. 1 Mod. 282.) In criminal cases, as of robbery on the high way, in action against the hundred; in rapes of women, or where a woman is married by force, &c. a man or a woman may be an evidence in their own cause. (1 Vent. 243.) And in private enormous cheats, a person may give evidence in his own cause, where nobody else can be a witness of the circumstances of the fact but he that suffers. (1 Salk. 286.) Upon an information on the statute against usury, he that borrows the money, after he hath paid it, may be an evidence, but not before. (Raym. 190.) Although an alien infidel may not be an evidence, a Jew may, and be sworn on the Old Testament. (1 Inst. 6.) A quaker shall not be an evidence in any criminal cause unless he will take an oath: though on other occasions his affirmation shall be accepted instead of an oath. Stat. 7 and 8 W. III. c. 34. See QUAKER.

The oath of a Gentoo, sworn according to the circumstances of his religion, has been admitted in a civil matter. (1 Atk. 21.) And by Willes C. J. an infidel in general is an admissible witness, for the term does not imply that he is an atheist; but whenever it appears that a witness hath no idea of a God or religion, he shall not be permitted to give his testimony. (1 Atk. 40. 45.) When persons that are competent witnesses are served with a writ of *subpoena ad testificandum*, they are bound to appear at the trial on pain of 10*l.* to be forfeited to the king, to which the stat. 5 Eliz. cap. 9. has added a penalty of 10*l.* to the party aggrieved, and damages equivalent to the loss sustained by want of their evidence: but no witness, unless his reasonable expences be tendered him, is bound to appear at all; nor if he appears, is he bound to give evidence till such charges are actually paid him, except he resides within the bills of mortality, and is summoned to give evidence within the same. In a criminal cause, if a witness refuse to appear, and give evidence, being served with process, the court will put off the trial, and grant attachment against him; and as refusing to give evidence is a great contempt, the party may be committed and fined. (1 Salk. 278.) Preventing evidence to be given against a criminal is punishable by fine and imprisonment; and persons dissuading a witness from giving evidence, &c., and jurors or others, disclosing evidence given, are likewise offences punished in the same manner. (2 Hawk. P. C. c. 22.) Members of either house of parliament may be witnesses on impeachments. (State Trials, vol. ii. 612.) A person who hath a legacy in a will, is not a good witness to prove the will; but if he release his legacy, he may be a good evidence. (Skin. 704.) Thus also, a person who claims any benefit by a deed, may not be an evidence to prove that deed; and a person concerned in the same title of land in question will not be admitted as evidence. (Ibid. 705.) If a legatee is permitted to be sworn and examined, the counsel cannot afterwards except against his evidence. (1 Lord Raym. 730.) To obviate all difficulties, it is enacted by stat. 25 Geo. II. c. 6. that any devise to a person being witness to any will or codicil shall be void, and such person shall be admitted as a witness; and that any creditor attesting a will or codicil, by which his debt is charged upon land, shall be admitted

as a witness to the execution, notwithstanding such charge: the credit of every such witness being left to the consideration of the court and jury. The son of a legatee is no witness to a will in the spiritual court; but it is held he may be a good evidence to prove a nuncupative will, within the intent of the statute of frauds. (1 Lord Raym. 85.) See WILL.

One credible witness is sufficient evidence to a jury of any single fact in all civil actions, though the concurrence of two or more corroborates the proof; but in cases of high-treason, petit-treason, and misprision of treason, by statutes 1 Edw. VI. cap. 12. 5 and 6 Edw. VI. cap. 11. and 1 and 2 Ph. and Mar. cap. 10. two lawful witnesses are required to convict a prisoner, except in cases of coining and counterfeiting the seals, or unless the party shall willingly and without violence confess the same: and by stat. 7 W. III. cap. 3. the confession of the prisoner must be in open court; and both witnesses must be to the same overt-act of treason, or one to one overt-act, and the other to another overt-act of the same species of treason. Baron Montequieu, indeed, lays it down for a rule, Spirit of Laws, book xii. chap. 3. that those laws which condemn a man to death in any case, on the deposition of a single witness, are fatal to liberty.

All evidence is to be given in open court, in the presence of the parties, their attorneys, the counsel and all bystanders, and before the judge and jury: many advantages attend this way of giving testimony, *ore tenus*, a method familiar among the ancient Romans, as may be collected from Quintilian, Inst. Orat. lib. v. cap. 7. and it was continued as low as the time of Adrian; but the civil law, as it is now modelled, rejects all public examination of witnesses.

No witness is bound to give any answer by which he confesses or accuses himself of any crime. The court in criminal cases is to examine the witnesses, and not the prisoner or prosecutors. A witness shall not be permitted to read his evidence, but he may look at his notes to refresh his memory. A witness may not recite his evidence to the jury, after having gone from the bar, and he hath given his evidence in court; if he does, the verdict may be set aside. (Cro. Eliz. 159.) One that is to be an evidence at a trial, ought not to be examined before the trial, but by the consent of both parties, and a rule of court for that purpose. No evidence ought to be produced against a man, in a trial for his life, but what is given in his presence. State Trials.

Positive proof is always required whenever the nature of the case possibly admits of it.

Sometimes violent presumption will be admitted for evidence without witnesses; as where a person is run through the body in a house, and one is seen to come out of the house with a bloody sword, &c. but on this the court ought not to judge hastily, 1 Inst. 6. 673; and though presumptive and circumstantial evidence may be sufficient in felony, it is not so in treason. State Trials.

Though all presumptive evidence of felony should be admitted cautiously, for the law holds that it is better that ten guilty persons escape, than that one innocent suffer. (See PRESUMPTION.) Sir Matthew Hale lays down two rules, most prudent and necessary to be observed. 1. Never to convict a man for stealing the goods of a person unknown, merely because he will give no account how he came by them, unless an actual felony of such goods be proved: and, 2. Never to convict any person of murder or manslaughter, till at least the body be found dead; on account of two instances, which he mentions, where persons were executed for the murder of others, who were then alive, but missing. 2 Hal. P. C. 200.

Evidence by writings and records, is where acts of parliament, statutes, judgments, fines, and recoveries, proceedings of court, and deeds, &c. are admitted as evidence. The printed statute-book is good evidence upon a general act of parliament, which need not be pleaded; but in the case of a private act, it is otherwise; for there it must be pleaded and examined by the records of parliament before it can be admitted in evidence. Records and enrolments prove themselves; and a copy of a record or enrolment, sworn to, may be given as an evidence. (Co. Litt. 119. 262.) A record of an inferior court has been rejected in evidence; and the proceedings in county-courts, courts-baron, &c. may be denied, and then tried by a jury. But court-rolls of a court-baron, when shewn, are good evidence; and, in many cases, copies of the court-rolls are allowed as evidence. An ancient deed of thirty years standing proves itself; but modern deeds, and other writings, must be attested and verified by parol evidence of witnesses. The counterpart of a deed is no evidence, when the original is in being, and can be procured; though it may be, when the original cannot be procured. (Co. Litt. 225. 10 Rep. 92.) The counterpart of an ancient deed hath been admitted as evidence. (Mod. Caf. 225.) In case of a fine, a counterpart is good evidence of itself. (1 Salk. 287.) Although a witness swear to the hand and contents of a letter, if he never saw the party write, it will not be good evidence. If all the witnesses to a deed are dead, continual and quiet possession is presumptive evidence of the truth of it; yet it may receive farther credit by comparison of hands and seals. (Wood's Inst. 599.) When witnesses to deeds are dead, their hand-writing must be proved. (2 Inst. 118.) If one of several witnesses survive, a subpoena must be taken out against the living witness, and strict inquiry made after him, and affidavit made that he cannot be found, before the hand-writing of the deceased witnesses is to be proved. (1 Litt. 556.) And a shop-book may not be given in evidence for goods sold, &c. by 7 Jac. I. cap. 12. after one year, before the action brought, except there be a bill, &c. for the debt; unless between merchant and merchant in the usual intercourse of trade. In order to make books evidences, if the servant who was accustomed to make entries in it be dead, his hand must be proved; and this, when accompanied with other collateral proofs of fairness and regularity, is the best evidence that can then be produced. In debt, a release may be given in evidence; so may any matters of fact, tampering with witnesses, or fraud.

In order to prove a lease for years, nothing shall be admitted but the very deed of lease itself, if in being; but if that be positively proved to be burnt or destroyed, then an attested copy may be produced, or parol evidence given of its contents. No evidence of a discourse with another will be admitted, but the man himself must be produced: yet in some cases, as in proof of any general customs or matters of common tradition or repute, the courts admit of *hearsay* evidence, or an account of what deceased persons have declared in their life-time; but such evidence will not be received of any particular facts. The probate of a will, when it concerns merely personal estate, may be given in evidence; but where title of lands is claimed under a will, the original will must be shewn, not the probate, though if the will be proved in the Chancery, copies of the proceedings there will be evidence. (2 Rol. Abr. 687. Trials per pais, 234. 1 Salk. 286. Raym. 335.) In some cases the ledger-book of the ecclesiastical court in which the will is entered is sufficient evidence, being a roll or record of the court. (Bull. N. P. 245, 6.) Depositions of witnesses in Chancery between the same parties may be given as evidence at law, if

the witnesses are dead, and the bill and answer proved. Depositions before a coroner are admitted as evidence, the witnesses being dead, or gone beyond sea. (1 Lev. 180. 2 Nelf. Abr. 760.) The confession of a prisoner before a magistrate, &c. may be given in evidence against him. (See 2 Hawk. P. C. c. 46.) See Baron Gilbert's Treatise of Evidence, or the Introduction to the Law of Nisi Prius, 4to. 1767.

From this treatise the following rules of evidence are extracted. 1. In general, the best evidence must be given that the nature of the thing will admit of. 2. No person interested in the question can be a witness. To this rule there are some exceptions; as, 1. A party interested may be admitted in a criminal prosecution in most instances. 2. He may be admitted for the sake of trade in the common usage of business, as porters, apprentices, &c. 3. Where no other evidence is reasonably to be expected. 4. Where he acquires his interest by his own act, after the party who calls him as a witness has a right to his evidence. 5. Where the possibility of interest is very remote. 3. The third general rule is that hearsay is no evidence. 4. In all cases where a general character or behaviour is put in issue, evidence of particular facts may be admitted; but not where it comes in collaterally. 5. In every issue the affirmative is to be proved. 6. No evidence need be given of what is agreed by the pleadings, &c. &c. See PLEADING.

Sir Thomas Smith restrains evidence to authentic writings of contracts, written, sealed, and delivered. De Rep. Ang. lib. ii.

EVIDENCE, *demurrer to*. See DEMURRER.

EVIDENCE, *exception to*. See EXCEPTION.

EVIL, MALUM, in *Ethics*, a privation or absence of some proper or necessary good, or of some measure or degree thereof.

Evil is either *natural* or *moral*; between which there is this relation, that moral evil produces natural.

EVIL, *moral*, is defined a deviation from right reason; a discernment of right from wrong, being given us as a guide of our actions; or it is the disagreement between the actions of a moral agent and the rule of those actions, whencesoever it is derived, and howsoever made known; and no action can be morally evil unless the agent be properly such, intelligent and free, and capable of distinguishing, choosing, and acting for himself. This the philosophers call *inhonestum*, and *turpe*, as staining the image of God, and fulying our original beauty; likewise *malum culpæ*.

EVIL, *natural*, is a want of something necessary to the *benefic*, or perfection of a thing, or to its answering all its purposes; such are defects of the body, blindness, lameness, hunger, diseases, death. This species is denominated *triste, injucundum, noxium, and malum pænæ*.

Good and evil, says a learned writer, are opposites, and arise from the relations which things have to each other: for since there are some things which profit, and others which prejudice one another; and since some things agree, and others disagree; we call the former good and the latter evil. Whatever, therefore, is incommodious or inconvenient to itself or any thing else; whatever becomes troublesome or frustrates any appetite implanted by God; whatever forces any person to do or suffer what he would not, that is *evil*. These inconveniences appear to be of three kinds: those of imperfection; those that are natural; and those that are moral. By the evil of imperfection we may understand the absence of those perfections or advantages which exist elsewhere, or in other beings; by natural evil, pains and uneasinesses, inconveniences and disappointments of appetites arising from natural motions; and by moral evils, vicious elections, that is, such as are hurtful to ourselves,

or others. This opinion is otherwise stated in the following manner: all evil is inconveniency, but some inconveniencies arise from the series of natural causes without our consent, and sometimes our knowledge; these we call natural evils; but others happen from the abuse of elections, when an undue choice occasions them; and in this case, besides the natural evil that arises from them, there is likewise an obligation on the person that makes the choice to answer for the hurt he has done by it. Now these choices that bring inconveniencies are called moral evils; and the difference between natural and moral evil is not their both bringing inconveniencies and injury to ourselves or others, for this constitutes the nature of their evil, but that the ill effects of the one proceed from the choice, those of the other from natural causes; and hence the author of that choice is answerable for the one, but nobody for the other. Moral evil, therefore, is natural evil, with choice superadded. See archbishop King's "Essay on the origin of Evil," by Law, vol. i. and ii. Sherlock, also, in his "Treatise on Judgment," p. 20, &c. distinguishes in a similar manner between moral and natural good and evil; the only difference between them, he says, is this, "that moral good and evil is in the will and choice, natural good and evil is in the nature of things; that which is good or hurtful to ourselves or others is naturally good or evil; to love, to choose, to do that which is good or hurtful to ourselves or others, is morally good or evil, or is the good or evil of our choice or actions. If you will but recollect yourselves, you will find that you have no other notion of good or evil but this; when you say such a man has done a very good or very evil action, what do you mean by it? Do you not mean, that he has done something very good or very hurtful to himself or others? When you hear that any man has done good or evil, is not the next question, what good or what hurt has he done? And do not you mean by this, natural good or evil? which is a plain evidence that you judge of the moral good or evil of actions by the natural good or evil which they do."

The ingenious author of the "Enquiry into the Origin of our Ideas of Beauty and Virtue," gives the following statement of the nature of moral good and evil, and of the difference between these and natural good and evil. Moral evil, according to this philosopher, denotes our idea of a quality apprehended in actions which excites aversion and dislike towards the actor, even from persons who receive no disadvantage thereby; as moral goodness denotes our idea of a contrary quality which procures approbation and love towards the actor, even in persons unconcerned in its natural tendency. This notion supposes an universally acknowledged difference of moral good and evil from natural. Moral good, we all know, procures love towards those we apprehend possessed of it; whereas natural good does not. How differently, for instance, are we affected towards those we suppose possessed of honesty, faith, generosity, &c. when we expect no benefit from those qualities, and those possessed of the natural goods, as houses, lands, gardens, health, strength, &c. So whatever quality we apprehend morally evil, raises our hatred towards the person in whom we observe it; as treachery, cruelty, ingratitude, &c. whereas we love and pity many exposed to natural evils, as pain, hunger, sickness, &c.

The origin of these different ideas of actions has greatly puzzled the moralists: some make self-interest, or self-love, the source of them all; we approve the virtue of others as it has some small tendency to our happiness, either from its own nature, or from this general consideration, that a conformity to nature and reason is in the general advantage-

ous to the whole, and to us in particular; and on the contrary, disapprove the vice of others, as tending at the long run to our particular detriment.

Others suppose an immediate natural evil in the actions called *vicious*, that is, that we are determined to perceive some deformity or displeasure in such actions, without reflecting on any disadvantage that may any way redound to us from the action; and that we have a secret sense of pleasure accompanying such of our own actions as are called *virtuous*, when we expect no farther advantage from them; but then they add, that we are excited to perform those actions, even as we pursue or purchase pictures, statues, landscapes, &c. from self-interest, to obtain the pleasure which accompanies the action.

But the author just mentioned maintains that some actions have to men an immediate goodness, and others an immediate evil, *i. e.* we perceive pleasure in some and pain in others, and are determined to love or hate the doers, without any view of natural advantage, without any view to future rewards or punishments, or even without any intention to obtain the sensible pleasure of the good, but from a very different principle, *viz.* an internal moral sense, or a natural determination of the mind to receive amiable or disagreeable ideas of actions, when they shall occur to our observation, antecedently to any opinion of advantage or loss to redound to ourselves from them, even as we are pleased with a regular form or an harmonious composition, without any knowledge of the mathematics, or seeing any advantage in that form or composition different from the immediate pleasure. But according to this account of Dr. Hutcheson, however plausible, moral good and evil signify nothing in the objects themselves, to which they are applied, any more than agreeable and harsh, sweet and bitter, &c. but only certain effects in us; and virtue is a mere affair of taste; whereas it seems to be much more just to conclude, that right and wrong, or good and evil, are real qualities of actions, and not merely of our minds; and that the power whereby we perceive these qualities is not any arbitrary sense but the understanding: or to suppose with another excellent writer, that moral good, considered as synonymous with virtue, denotes the doing good to mankind, in obedience to the will of God, and for the sake of everlasting happiness, and moral evil or vice, the contrary. Price's Original of our Ideas, &c. p. 13, and p. 59, &c. Paley's Principles of Moral and Political Philosophy, vol. i. p. 41. See farther under DEFORMITY, SENSE, GOOD, VIRTUE, and VICE.

The question concerning the origin of evil has very much perplexed philosophers and divines, both ancient and modern. Plato, for the solution of this question, maintained, that matter, from its nature, possesses a blind and refractory force, from which arises in it a propensity to disorder and deformity; and that this is the cause of all the imperfection which appears in the works of God, and the origin of evil. Matter, he conceives, resists the will of the supreme artificer, so that he cannot possibly execute his designs; and this is the cause of the mixture of good and evil, which is found in the material world. "It cannot be," says he, (Theæt. t. i. p. 176.) "that evil should be destroyed, for there must always be something contrary to good;" and again, "God wills, as far as it is possible, every thing good, and nothing evil." What is that property of matter which opposes the wise and benevolent intentions of the first intelligence, Plato has not clearly explained, but he speaks of it as *ἑτέροφρωνος ἐπιθυμία*, an innate propensity to disorder, (Phileb.) and says, "that before nature was adorned with its present beautiful forms, it was inclined to confusion and deformity, and that from this ha-

bitude arises all the evil which happens in the world." Plutarch supposes the Platonic notion to be, that there is in matter an unconscious irrational soul; and this supposition has been adopted by several modern writers. But the writings of Plato afford no evidence, that he conceived the imperfection of matter to arise from any cause distinct from its nature. Such a notion is incongruous with Plato's general system, and it is contrary to the doctrine of the Pythagorean school, to which he was probably indebted for his notions on this subject; for the philosophers of that sect held, that motion is the effect of a power essential to matter. Some of the Stoics adopted the notion of the Platonists concerning the origin of evil, and ascribed it to the defective nature of matter, which it is not in the power of the great artificer to change; asserting, that imperfections appear in the world, not through any defect of skill in its author, but because matter will not admit of the accomplishment of his designs. But it was perceived by others, that this hypothesis was inconsistent with the fundamental doctrine of the Stoics concerning nature. For since, according to this system, matter itself receives all its qualities from God, if its defects be the cause of evil, these defects must be ultimately ascribed to him. No other way of relieving this difficulty remained, but to have recourse to fate, and say, that evil was the necessary consequence of that eternal necessity, to which the great whole, comprehending both God and matter, is subject. Thus, when Chryssippus was asked, whether diseases were to be ascribed to divine Providence, he replied, that it was not the intention of nature that these things should happen; nor were they conformable to the will of the author of nature and parent of all good things; but that, in framing the world, some inconveniences had adhered, by necessary consequence, to his wise and useful plan. To others the question concerning the origin of evil appeared so intricate and difficult, that finding themselves unequal to the solution of it, they denied either that there is any God at all, or, at least, any author or governor of the world. The Epicureans belonged to this class; nor does Lucretius allege any other reason for denying the system of the world to be the production of a deity besides its being so very faulty. Others again judged it to be more rational to assign a double cause of visible effects than to assign no cause at all; as nothing, indeed, can be more absurd than to admit actions and effects without any agent and cause. These persons, perceiving a mixture of good and evil, and being persuaded that so many inconsistencies and disorders could not proceed from a good being, supposed the existence of a malevolent principle, or God, directly contrary to the good one; hence they derived corruption and death, diseases, griefs, mischiefs, frauds and villainies, whilst from the good being they deduced nothing but good. This opinion was held by many of the ancients; by the Persian magi, Manichæans, Paulicians, &c. &c. See these articles, and also ZORASTER. Absurd as this hypothesis was, it very long and generally prevailed, not only in the Heathen but in the Christian world; nor have the light and influence of Christianity yet availed to its total extermination, so that no trace or remnant of it remains. Those who wish to find a satisfactory refutation of it, may consult "King's Origin of Evil," vol. i. and the annexed notes of the editor.

The excellent Dr. Clarke, in his "Demonstration of the Being and Attributes of God," deduces from the possibility and real existence of human liberty an answer to the question, what is the cause and original of evil? "For liberty," he says, "implying a natural power of doing evil, as well as

good; and the imperfect nature of finite beings, making it possible for them to abuse this their liberty to an actual commission of evil; and it being necessary to the order and beauty of the whole, and for displaying the infinite wisdom of the Creator, that there should be different and various degrees of creatures, whereof, consequently, some must be *less perfect* than others; hence there necessarily arises a possibility of evil, notwithstanding that the Creator is infinitely good. In short thus: all that we call *evil*, is either an *evil of imperfection*, as the want of certain faculties and excellencies which other creatures have; or *natural evil*, as pain, death, and the like; or *moral evil*, as all kinds of *vice*; the first of these is not properly an evil. For every power, faculty, or perfection, which any creature enjoys, being the free gift of God, which he was no more obliged to bestow, than he was to confer being or existence itself; 'tis plain the want of any certain faculty or perfection in any kind of creatures, which never belonged to their nature, is no more an evil to them, than their never having been created or brought into being at all, could properly have been called an evil. The *second* kind of evil, which we call *natural evil*, is either a necessary consequence of the former; as *death*, to a creature on whose nature immortality was never conferred; and then 'tis no more properly an evil than the former; or else 'tis counterpoised, in the whole, with as great or greater good; as the *afflictions and sufferings of good men*; and then also it is not properly an evil; or else, lastly, 'tis a *punishment*; and then 'tis a necessary consequent of the *third* and last sort of evil, *viz. moral evil*. And this arises wholly from the abuse of *liberty*, which God gave to his creatures for other purposes, and which 'twas reasonable and fit to give them for the perfection and order of the whole creation: only they, contrary to God's intention and command, have abused what was necessary for the perfection of the whole, to the corruption and depravation of themselves. And thus all sorts of evils have entered into the world, without any diminution to the infinite goodness of the Creator and Governor thereof.

EVIL, or *King's Evil*, the appellation formerly given to *scrofula*, in consequence of the supposed power possessed by the kings of England and France of curing this disease by *touching* the sick.

The origin and first exercise of this royal faculty are not agreed upon by historians; those of France are disposed to maintain, that it was originally inherent in their kings, some asserting that St. Louis, others that king Robert, was the first who was thus gifted; but by most other writers it is assigned as an earlier prerogative of the English crown. Edward the Confessor is generally mentioned as the first possessor of this miraculous power: and it was disputed in the days of Malmsbury, who lived not long after his reign, whether this faculty were a peculiar reward from heaven for that king's sanctity, or hereditarily resident in the English crown. Polydore Virgil has noticed this gift to Saint Edward, and its continuance in the line of his successors; and Dr. Harpsfield, in his Ecclesiastical History of England, after describing the miracles of the Confessor, observes, "quam strumofos sanandi admirabilem dotem in posteros suos Anglorum reges, ad nostra usque tempora transfudisset perpetuasse, merito creditur." The practice was long continued, and seems to have reached its greatest height in the reign of Charles II. to whom multitudes flocked to receive the benefits of the royal touch; inasmuch, that after his restoration, he is said to have laid his hands upon more than six thousand persons in one year. His majesty was therefore obliged to make some restrictions with regard to the times of healing, and the number of patients. All persons were obliged to go to the king's surgeon, whose duty it was to examine

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examine their certificates from the minister and church-wardens of their parish, to determine whether they were proper objects, to give them tickets of admission to the royal presence, and to introduce every one to the king's sacred hand to be touched. The king usually gave public notice of the day of healing; in the winter the ceremony was always held at Whitehall; in the summer sometimes at Whitehall, and sometimes at Windsor.

The following curious paragraphs were made public in 1660.

"The kingdom having been for a long time troubled with the evil, by reason of his majesty's absence, great numbers have lately flocked for cure. His sacred majesty, on Monday last, touched 250 in the Banqueting house; among whom, when his majesty was delivering the gold, one shuffled himself in, out of an hope of profit, which had not been stroked, but his majesty quickly discovered him, saying, this man hath not yet been touched. His majesty hath for the future appointed every Friday for the cure, at which 200, and no more, are to be presented to him, who are first to repair to Mr. Knight, the king's surgeon, &c. Parliamentary Journal, July 2—9, 1660.

"Saturday being appointed by his majesty to touch such as were troubled with the evil, a great company of poor afflicted creatures were met together, many brought in chairs and flasks; and being appointed by his majesty to repair to the Banqueting-house, his majesty sat in a chair of state, where he stroked all that were brought to him, and then put about each of their necks a white ribbon, with an angel of gold on it. In this manner his majesty stroked above six hundred; and such was his princely patience and tenderness to the poor afflicted creatures, that though it took up a very long time, his majesty, who is never weary of well-doing, was pleased to make inquiry whether there were any more that had not yet been touched. After prayers were ended, the duke of Buckingham brought a towel, and the earl of Pembroke a basin and ewer, who, after they had made obeisance to his majesty, kneeled down till his majesty had washed." Mercurius Politicus, June 21—28, 1660.

An exact register was at that time kept of the number of cases that came for relief, and the whole amount is very great. From 1660 to 1664 inclusive, a period of five years, 23,601 persons were touched by Charles II.: and from May 1667 to May 1684, the number of persons touched amounted to 68,506; making all together 92,107. For the intervening years, 1665 and 1666, no register was made, the king having removed from the metropolis on account of the plague.

This superstitious practice was dropped by the present royal family, "who observed (says Hume) that it could no longer give amazement, even to the populace, and was attended with ridicule in the eyes of all men of understanding." Rapin indeed remarks, that "the late king William III. of glorious memory, was so persuaded he should do no injury to persons afflicted with this distemper, by not touching them, that he refrained from it all his reign." The practice continued in vogue in the reign of queen Anne; it is recorded of Dr. Johnson, that he was touched by that princess, but without effect.

It is extraordinary that this belief in the efficacy of the royal touch in the cure of this severe disease was by no means confined to the vulgar, nor to persons unacquainted with the nature and cure of diseases. Dr. Johnson's mother is said to have been instigated by the advice of a celebrated physician, sir John Floyer, to bring her son to London for the purpose of receiving the remedy. And Wiseman

and Browne, eminent surgeons of their day, and surgeons to the king (Charles II.) have given their strongest testimony in favour of the superiority of the royal remedy, over any which their art possessed. "I must needs profess," says Wiseman, "that what I write will do little more than shew the weakness of our ability, when compared with his majesty's, who cureth more in any one year, than all the chirurgeons of London have done in an age. However, that this attempt may not seem to want precedent, give me leave to tell you, that it is no more than the French kings' chirurgeons have done before me, or than old Mr. Clows did in queen Elizabeth's days, and all other general writers in chirurgery have done more or less." And he affirms that he had been "a frequent eye-witness of many cures performed by his majesty's touch alone, without any assistance of chirurgery; and those many of them such as had tired out the endeavours of able chirurgeons before they came thither."

The other surgeon royal just mentioned has left us the most circumstantial account of this royal healing, in a publication, entitled "Adeno-choiradologia; or, an Anatomick-Chirurgical Treatise of Glandules and Strumæ, or King's-evil-swellings, together with the Royal Gift of Healing, or Cure thereof, by Contact or Impolition of Hands, performed for above 640 years by our kings of England; continued with their admirable effects and miraculous events; and concluded with many wonderful examples of Cures by their sacred touch. All of which are succinctly described by John Browne, one of his Majesty's Chirurgeons in Ordinary, and Chirurgeon of his Majesty's Hospital, London, 1684." His offices evince that the author was a man of character, and his book is approved, as was the custom of his time, by the president and several fellows of the College of Physicians. Like Wiseman, he seems to have been a staunch loyalist, and a vehement defender of the divine right of kings; he detested all dissenters, and confidently asserts that the usurper, Cromwell, tried in vain to exercise this royal prerogative, "he having no more right to the healing power, than he had to the regal jurisdiction." The third part of the treatise of Browne, which is devoted to the history and nature of the royal gift, is entitled *Charisma Basilicon*. Besides an historical view of this prerogative, it contains rules for the meanest capacity to find out the disease, which were deemed expedient to prevent poor people from unnecessary journeys; and sixty admirable cures, performed with or without gold, are circumstantially detailed, as well as several cases of scrofulous tumours and sores, which disappeared on being touched with handkerchiefs dipped in the blood of Charles I.

Some shrewd suspicions had, indeed, been thrown out; that the piece of gold, given by the king on the occasion, was the most efficacious remedy employed; and the above mentioned writers are anxious to refute such a slander on the royal qualifications. The author of a late treatise tells the following story, which may, in some degree, account for the numbers registered at Whitehall. "An old man, who was witness in a cause, had by his evidence fixed the time of a fact, by queen Anne having been at Oxford, and touched him while a child, for the cure of the evil. When he had finished his evidence, the relator had an opportunity of asking him whether he was really cured. Upon which he answered, with a significant smile, that he believed himself never to have had a complaint, that deserved to be considered as the evil; but that his parents were poor, and had no objection to the bit of gold." See Wiseman's Chirurgical Treatises, book iv. chap. 1. Browne above cited. Edin. Med. and Surg. Journal, vol. iii. p. 185.

With

With respect to the nature of the disease, vulgarly called *King's Evil*, and the practice now adopted for its cure, see SCROFULA.

EVIL, *falling*, in *Horses*. See FALLING-EVIL.

EVIL, *hungry*. See HUNGRY and BULIMY.

EVIRATUA, in *Geography*, a town of Brasil, on the river of the Amazons, 36 miles W. of Fort Rio Negro. S. lat.  $2^{\circ} 50'$ .

EVIT'S CREEK, a river of America, in Maryland, which runs into the Potomack. N. lat.  $39^{\circ} 38'$ . W. long.  $78^{\circ} 44'$ .

EUKSINEH, a town of Asiatic Turkey, in Natolia; 10 miles N. E. of Eregri.

EULÆUS, in *Ancient Geography*. See CHOASPES.

EULBACH, or EULENBACH, in *Geography*, a town of Germany, in the county of Erbach; 3 miles N. E. of Erbach.

EULE, a town of Bohemia, in the circle of Kaurzim; 12 miles S. of Prague. N. lat.  $49^{\circ} 55'$ . E. long.  $14^{\circ} 31'$ .

EULENBERG, a town of Moravia, in the circle of Olmutz; 14 miles N. of Olmutz.

EULENBURG, a town of Saxony, in the circle of Leipzig, situated on an island in the Mulda, and containing three churches. Beer is the principal article of trade. It is 12 miles N. E. of Leipzig. N. lat.  $51^{\circ} 27'$ . E. long.  $12^{\circ} 38'$ .

EULEPA, in *Ancient Geography*, a town of Cappadocia. Itin. Anton.

EULER, LEONARD, in *Biography*, a great mathematician, was born at Basil in the year 1707, where he was educated. He performed his academical tasks with so much rapidity, that he had a good portion of time left at his own command, which he consecrated to the study of the mathematics. In the pursuit of this kind of knowledge, he was assisted by John Bernouilli, who was regarded as one of the chief mathematicians of Europe, and whose distinguished attention and esteem he obtained, by his early proficiency and unwearied application. In 1723, M. Euler was admitted to the degree of M. A. on which occasion he obtained great applause by delivering a Latin discourse, wherein he drew a comparison between the philosophy of Newton and the Cartelian system. In compliance with his father's desire, he applied himself to theology and oriental literature, in which he made no inconsiderable progress, but his predominant bias still leading him to the mathematics, his father allowed him to follow the bent of his inclination. In the course of his studies under Bernouilli, he contracted an intimate friendship with his two sons, Nicholas and Daniel, which proved to be of the highest advantage to him in after life. Those two celebrated mathematicians having been invited to Petersburg, in the year 1725, by Catharine I. for carrying into execution the project of Peter the Great, for the establishment of an academy of science, promised Euler to use their endeavour to find him a situation in that city. By their advice he applied himself diligently to the study of natural knowledge, and attended the lectures of all the eminent professors of Basil. While engaged in these pursuits he composed a dissertation "On the nature and propagation of Sound;" and also an answer to a prize question, "Concerning the masting of Ships," which obtained the second prize. By this circumstance his attention was early drawn to the curious and important studies of naval architecture and navigation, which he contributed greatly to enrich in the subsequent periods of his life. He now joined his friends the Bernouillis at Petersburg, and was appointed with them a joint professor in the university of that city. In this situa-

tion his talents and genius were so far called into exercise as to entitle him to rank among the most eminent mathematicians. He contributed many memoirs to the academical collection, which excited a noble spirit of emulation between him and his two friends, unalloyed by the least mixture of envy or jealousy, and such as produced no alteration in their friendship. The integral calculus he carried to new degrees of perfection; invented the calculation of sines; simplified analytical operations, and in this way threw new light on all the branches of mathematical science. In 1730, M. Euler was appointed professor of natural philosophy; and, in 1733, he succeeded his friend Daniel Bernouilli, in the mathematical chair. In 1735, the academy proposed an intricate and important problem for solution, which Euler completed in three days, though it was supposed to be the labour of many months. The exertion on this occasion was so violent that it produced a fever which endangered his life, and deprived him of the use of one of his eyes. In the year 1740, the Academy of Sciences at Paris proposed for solution the important subject of "The flux and re-flux of the sea." To this Euler applied the force of his genius, and produced a memoir, which was allowed to be a master piece of analysis and geometry. He had, however, as competitors, Daniel Bernouilli, and our countryman, Colin Maclaurin, with whom he shared the prize. In 1741, Euler, at the express invitation of the king of Prussia, repaired to Berlin, where his industry and talents appeared to great advantage. He furnished many essays for the memoirs of the Prussian academy, without withholding his contributions from the academy of Peterburgh, which was now encouraged by the patronage and munificence of the empress Elizabeth. In 1742, he obtained a pension from the academy at Peterburgh, and in 1766, by permission of the king of Prussia, he returned to that city, to spend the remainder of his days; when the munificence of Catharine II. liberally rewarded him for the preference which he exhibited towards his Peterburgh connections. Shortly after his return he lost the sight of the other eye, yet in this deplorable situation he dictated to his servant, an unlettered youth, and who was entirely unacquainted with mathematical knowledge, his "Elements of Algebra," a work of high merit, and which has been translated into the English language. At this period he was elected one of the very few foreign members of the Academy of Sciences at Paris. After this he received from them the prize for his dissertations "Concerning the inequalities in the motions of the planets;" also two prizes for questions proposed relative to "A more perfect theory of the moon." He next reviewed his whole theory with the assistance of his son, and Messrs. Krafft and Lexell; and pursued his researches till he had constructed the new tables which appeared with the great work in 1772. "This work alone," says his biographer, "would be sufficient to render his name immortal, and when it is considered that it was completed after he was totally blind, and at a time in which he was embarrassed in his domestic circumstances by a dreadful fire, that had consumed great part of his substance, and forced him to quit the ruined house; it is impossible not to be struck with admiration and astonishment at the powers of his genius and memory, and the perseverance, fortitude, and tranquillity of mind which he must have possessed." Some time after this he underwent the operation of couching, which restored to him his sight; but either too eager to benefit by the organ, or by the negligence of his surgeon, he was a second time deprived of his sight, and the relapse was attended with much tormenting pain. Still he

he was active in the pursuit of science, and in the course of seven years transmitted to the academy of Petersburg seventy distinct memoirs, and left behind him two hundred more, which were afterwards revised and completed. In the beginning of September, 1783, he was seized with several attacks of a vertigo; these, however, did not prevent his calculating the motion of air-balloons, which then began to engage the attention of the philosophical world; but on the 7th of the same month, while he was amusing himself with his grand-children, an apoplectic fit terminated his illustrious career, at the age of 76. Besides being foreign member of the Royal Academy of Sciences at Paris, M. Euler was member of the Imperial Academy of Petersburg, ancient director of the Royal Academy of Berlin, and fellow of the Royal Society of London. His works were very numerous; his knowledge was not confined to his favourite studies of the mathematics and astronomy, of which he has secured to himself an imperishable fame. He had made much progress in medical, botanical, and chemical science. He also possessed, in a high degree, what is generally called erudition. He had read with attention and taste the most eminent Latin classics, and was familiarly acquainted with the civil and literary history of all ancient and modern nations. His uncommon memory seemed to retain every idea that was conveyed to it either from reading or from meditation. The *Æneid* of Virgil he could repeat from the beginning to the end, and point out to his hearers the first and last line of every page in the edition which he used. He enjoyed a vigorous constitution, and a surprising share of health, considering the intensity and ardour of his application. His manners were unaffected and pleasing, his temper lively and cheerful, and his conversation both instructive and entertaining. The evening of his days was calm and serene, sweetened in no small degree by the fame that follows genius, the universal esteem and respect that were due to his exemplary virtues, and the satisfaction which he received from the kind offices of friendship, and the endearments of domestic felicity.

This great geometrician had bestowed much meditation, early in life, on harmonics, or the philosophy of sound; for in 1739, at the age of 32, he published at Petersburg, in Latin, a work in 4to. under the title of "Tentamen novæ Theoriæ Musicæ ex certissimis harmoniæ principii dilucidè expositæ, auctore Leonardo Eulero." This work, being written in Latin, and requiring in the reader, besides that language, a knowledge in geometry, algebra, and fluxions, was little noticed by the public at large on its first appearance, and still less understood by musicians, for whose use it must have been chiefly intended. It, however, set mathematicians and men of science to work, and started many curious subjects of meditation to such as interested themselves in the study of harmonics.

But we do not very well see how the author could with propriety call his treatise an attempt at a *new* theory of music. The ratios were all known ever since the time of Euclid. Indeed he has followed the proportions which Zarlino tried to establish in his "Institutioni," which had been adopted by Des Cartes, Rameau, Tartini, &c.; and Des Cartes, and others after him, had accounted for the pleasure which we receive from concords, by the simplicity of the ratios between the sounds which form them. There is a plate, p. 35, representing, we thought, in a new and ingenious manner to the eye, the pulsations of two strings; the one fixed to a given tone, and the other tuned progressively to all the consonant intervals, which clearly shews the coincidences of vibration, upon the frequency of which the

degree of sweetness and perfection in concords depends. We believe, however, that this was done in the 17th century, but in a less elegant manner, by our countryman lord keeper North, in a quarto pamphlet of only twenty-five pages, intitled, "A Philosophical Essay of Musick directed to a Friend;" London, 1677.

In this little tract the vibrations of each consonance are represented to the eye, and the coincidences with the fixed tone, its base or principal, in the same manner as in the work of the great geometrician Euler, who has pushed ratios as far as our perception and appreciation can go, extending the whole compass of our musical system to eight octaves. See COMPASS.

The degrees of suavity in consonance from the simplicity of ratios and frequency of coincidence, had, we believe, been settled before the year 1739, when this treatise was published.

The following is a translation of the titles of the several chapters of this work. After a preface of twenty pages, Chap. I. treats of sound, and the auditory sense.

- II. Of the sweetness and principles of harmony.
- III. Of music in general.
- IV. Of concords.
- V. Of concords in succession.
- VI. Of a series of concords.
- VII. Of intervals, and their names.
- VIII. Of the genera of music.
- IX. Of the diatonic-chromatico genus.
- X. Of other more compounded genera.
- XI. Of the concords in the diatonic-chromatico genus.
- XII. Of the modes or keys and systems in the diatonic-chromatico genus.
- XIII. Of the ratio of composition in a given mode and system.
- XIV. Of the modes and systems in transposed keys.

In the 13th chap. on the laws of composition, and the possible combinations in any given mode, key, or system, some of these combinations employ every note in the scale, seemingly at once, which would be extremely offensive if heard together. The author probably means, that all these sounds may be heard successively in melody, provided they are in tune, and have a fundamental base.

Upon the whole, Euler seems not to have invented much in this treatise; and to have done little more than arrange and methodize former discoveries in a scientific and geometric manner. He may, indeed, not have known what antecedent writers had discovered before; and though not the first, yet to have imagined himself an inventor.

EULER'S *Logarithms*, or *Binary Logarithms*, are a species of artificial numbers contrived by M. Euler to facilitate the calculation and comparison of musical intervals, which they do, by representing each interval in *decimal parts* of the octave, which is 1 in this notation, the successive octaves or powers of 2 being represented by 2, 3, 4, &c. as in the following table, for the first 10 numbers, *viz.*

1 = 0.000000	6 = 2.584963
2 = 1.000000	7 = 2.807356
3 = 1.584963	8 = 3.000000
4 = 2.000000	9 = 3.169925
5 = 2.321928	10 = 3.321928

By help of the primes which compose musical ratios, and their binary logarithms in this table, the Euler's logarithm may be found, which answers to any interval: as the names of the several intervals occur, we shall give their binary logarithms.

**EULISIA**, in *Ancient Geography*, a country of Scythia, towards the Palus Mæotis.

**EULOGIUS**, in *Biography*, patriarch of Alexandria, was, at first, presbyter of the church of Antioch, and distinguished himself by his zeal for the Catholic doctrines in a letter which he wrote to Eutychius, patriarch of Constantinople, containing an exposition of the true faith. He was elevated to the see of Alexandria in the year 581, and became very active in rooting out heresy, not only by the allowable and fair weapons of reason and argument, but by expelling from their situation all ecclesiastics who were advocates for the doctrine of one nature in Christ. He lived in habits of intimacy with Gregory the Great, whose sentiments and disposition were congenial to his own. He died in 608. Of his works only fragments are remaining. Moreri.

**EULOGIUS**, elected archbishop of Toledo in the ninth century, was born at Cordova about the year 800. He was educated for the priesthood, and discharged the duties of that office with zeal and activity till the year 844, when he was driven into exile by the Saracens for his boldness in maintaining the principles of the Catholic faith. After much suffering he ventured to return to Cordova, where, in the year 850, he was thrown into prison on account of his religion. In the dungeon he employed himself in writing animating exhortations to the Christians, to support and console them under their persecution, for conscience sake, and to encourage them to undergo the severest trials rather than disgrace themselves by apostacy. He was afterwards liberated, and by his personal labours, as well as writings, persevered in fortifying his fellow Catholics against the arts and terrors of their enemies. As a reward for his exertions in this hazardous employment, he was chosen to fill the vacant see of Toledo; but he was put to death before he could receive the episcopal consecration. The accusation against him was the having converted a young Mahometan female to the Christian faith: he was beheaded in 859. He was author of "Memoriale Sanctorum, five Libri III. de Martyris Cordubensibus;" "Apologeticus pro Martyribus, &c.;" "Exhortatio ad Martyrium;" and some moral epistles. These were collected and printed with notes by Ambrosius Moralis in 1554, and again in a more correct form by Poncius Leo in 1574. Moreri.

**EULOGY, EULOGIA**, in *Church History*. When the Greeks have cut a loaf, or piece of bread, to consecrate it, they break the rest into little bits, and distribute it among the persons who have not yet communicated, or send it to persons that are absent; and these pieces of bread are what they call eulogies.

The word is Greek, *εὐλογία*, formed of *εὐ*, bene, well, and *λέγω*, dico, I say, speak; q. d. *benedictum, bless'd.*

The Latin church has had something like eulogies for a great many ages; and thence arose the use of their holy bread.

The name eulogy was likewise given to loaves or cakes brought to church by the faithful to have them blessed.

Lastly, the use of the term passed hence to mere presents made a person, without any benediction. See the Jesuit Gretser, in his *Treatise de Benedictionibus & Maledictionibus*, lib. ii. cap. 22. 24, &c. where he treats of eulogies thoroughly.

From a passage in Bollandus, on the Life of S. Melaine, cap. 4. it appears, that eulogies were not only of bread, but any kind of meat blessed and hallowed for that purpose. And that almost every body blessed and distributed eulogies; not only bishops and priests, but even hermits,

though laymen, made a practice of it. Women also would sometimes send eulogies.

The wine sent as a present was also held an eulogy. Bollandus remarks farther, that the eucharist itself was also called eulogy.

**EULOGY**, likewise, means an encomium on any person, on account of some virtue or good quality.

**EUMARIDES**, of *εὐμαρίς*, *easy*, among the *Ancients*, a kind of shoes common to men and women.

The eumarides were used for pomp and delicacy, being neat, and painted with various colours.

**EUME**, in *Geography*, a river of Spain, which runs into the sea near Corunna.

**EUMECES**, in the *Writings of the Ancient Naturalists*, the name of a dove which Pliney tells us resembled a flut, and was found in Bactria; the ancients had an idle opinion, that, if laid under the head, it occasioned true and prophetic dreams, foretelling to the person the more remarkable future events of his life. Hist. Nat. lib. xxxvii. cap. 10.

**EUMENES**, in *Biography*, a captain under Alexander the Great, was a native of Cardiopolis, in the Thracian Chersonese. His father was of a low station, but one in a condition to have entertained at his house Philip king of Macedon, who became the patron of his son. So well did the youth approve himself as secretary to the monarch, that his son Alexander continued him in the same office, and gave him a command in the cavalry. According to Plutarch, Eumenes took every advantage that his station afforded him of accumulating money, for his tent being set on fire by the private orders of his sovereign, to whom he had refused the loan of three hundred talents; there was found to the value of more than one thousand talents in melted gold and silver. After the death of Alexander, when the provinces were divided among the principal commanders, the government of Cappadocia, Paphlagonia, and the country bordering on the Euxine sea, as far as Trapezium, which as yet were unconquered, were assigned to Eumenes. Eumenes attached himself to Perdiccas, who made him his chief minister, and gave directions to Antigonus and Leonatus to put him in possession of his government. Antigonus paid no attention to the order, but Leonatus, pretending to comply, marched an army seemingly for the purpose, which Eumenes joined. His design was, however, to seize the kingdom of Macedon for himself; but upon making it known, Eumenes deserted him by night, after seizing his treasures, and repaired to Perdiccas. In reward for his fidelity, Perdiccas himself made an expedition in Cappadocia, and after defeating and killing the king Ariathes, left Eumenes master of the country. He was next appointed prefect of Asia, between mount Taurus and the Hellespont, and was entrusted with the care of opposing the army expected to march against him out of Greece under Antipater and Craterus. On the approach of these great commanders, Eumenes concealed from his army that they were about to contend with Craterus, for whom they entertained the most profound respect and veneration, and giving battle to him and Neoptolemus, he slew the latter with his own hand, while Craterus was mortally wounded, fighting at the head of his phalanx. Eumenes, who felt for him emotions of the sincerest friendship, grasped his hand as he was expiring, wept over his remains, and honoured him with a magnificent funeral. After the murder of Perdiccas by his own army, Eumenes was declared a public enemy, and Antigonus was sent to conduct the war against him. Eumenes was routed, but able to retire to the impregnable castle of Nora, which he defended with great ability. He was abundantly supplied with corn, and though with-

out any other kind of provisions, he kept his men in good humour, by his affable and cheerful demeanour. Another scene opened itself for the ambition of Antigonus, and Eumenes was set at liberty. He instantly began to levy troops, and in a short time was declared royal general of Asia, and there was assigned to him a guard of Argyraspidæ, or silver shields. To inspire his troops with a sort of religious enthusiasm in the cause, he pretended to have seen Alexander in a vision, by whose direction he erected a royal tent, containing a throne of gold, with all the ensigns of majesty, where the captains were to offer incense, and then deliver their orders in a common council. After this there were disputes about the chief command, but when Antigonus approached all agreed that Eumenes was the only general, under whom they would fight. His situation was difficult and precarious, he was aware that many of the other commanders were desirous of getting rid of him, as the chief obstruction to their ambitious designs. From those whom he most suspected he borrowed large sums of money, that by such a pledge he might give them an interest in his security. The war was protracted with various success to a second campaign, when a battle ensued, in which Eumenes routed the enemies' infantry, but in the mean time his cavalry took possession of the camp of Eumenes. This circumstance occasioned so much discontent in the army, that when Antigonus sent an offer to restore the soldiers, their wives and property, on condition of their delivering Eumenes into his hands, the Argyraspidæ surrounded him, seized his sword, tied his arms behind him, and gave him up prisoner. Antigonus being asked how he should be kept? As you would keep a lion or a wild elephant, he replied. All the Asiatic chiefs submitted upon this event, and it remained only to determine the fate of the illustrious captive. This was so long kept in suspense, that Eumenes expressed his surprise that Antigonus had neither the courage to put him to death, nor the generosity to make him his friend by setting him at liberty. A party in the army, headed by Demetrius, favoured the last measure, but the majority urged Antigonus to remove so formidable a rival. This counsel prevailed, and orders were given to deprive him of food. He had suffered the pains of hunger two or three days, and was fast approaching his end, when the army being suddenly obliged to decamp, an executioner was sent to dispatch him. His remains were treated with funeral honours, and his ashes were enclosed in a silver urn, and sent to his family. This was in the year 315 B. C. Eumenes had a fine person, was highly accomplished, and possessed the manners and sentiments suited to an elevated station; he was faithful to the cause of his deceased master, and it was not till after his death that the captains who divided the Macedonian empire among them openly assumed the style of independent sovereigns. Eumenes perished in his forty-fifth year. Univer. Hist. Plutarch.

**EUMENES II.** king of Pergamus, succeeded his father Attalus in the year B. C. 197. He cultivated the friendship of the Romans, who were now beginning to extend their influence into Asia, urging them to check the ambitious projects of Antiochus the Great, of which he feared he should be the victim. Eumenes joined his fleet to that of the Romans, and by his personal bravery greatly contributed to a naval victory, which was gained over that king; nor was he less useful at the decisive battle of Magnesia. On account of his important services he was rewarded by an accession to his dominions, of all the countries west of mount Taurus, which had belonged to Antiochus, and also of all the provinces lying between that mountain

and the river Meander, except Lycia and Caria, which were given to the people of Rhodes. Eumenes, now one of the most potent princes in Lesser Asia, was involved in a war with Prusias, king of Bithynia, in which he was defeated both by land and sea. Peace was made, and another contest took place between Eumenes and Pharnaces; in this the latter was obliged to sue for peace. Eumenes now made an alliance with Antiochus, son of his old enemy Antiochus the Great, and in conjunction with his brother Attalus placed that prince on the throne of Syria, from which he had been driven by an usurper. Perseus, king of Macedon, by increasing his military force, excited the jealousy of his neighbours, and Eumenes took a journey to Rome, for the purpose of acquainting the senate with all he had discovered of his dangerous projects. On his return, Eumenes, going to offer sacrifice at the temple of Delphi, had nearly lost his life by assassins hired by Perseus to destroy him. He received so much injury that he was carried almost lifeless on board his ship, and it was generally believed that he was actually dead. Attalus his brother, giving credit to the news, assumed the royal ensigns, and even married the queen Stratonice. Eumenes, after his recovery, gave his brother a friendly reception, advising him not to marry his wife again till it was certain he was dead. From this period he was engaged in contests with the Romans, who began to regard him with suspicion, and it is thought they encouraged Attalus to seize upon his brother's kingdom for himself. Eumenes died in the year 159 B. C. leaving an infant son to the protection of his brother and successor Attalus. Eumenes was liberal, and even magnificent towards his friends. He was a patron of letters, and made considerable additions to the celebrated library of Pergamus. Univer. Hist.

**EUMENES**, an orator; was an Athenian by descent, but was born at Autun in Gaul, where he was for a considerable time professor of rhetoric, and acquired great reputation. He was secretary to the emperors Maximian and Constantius, and was much esteemed by Constantine the Great, whom he harangued in favour of the inhabitants of Autun in 311. He delivered an oration before the prefect of Lyonesse Gaul, in favour of the restoration of the public schools in the province, towards which he nobly offered to contribute his own salary, as secretary, probably, as well as professor. He died about the middle of the fourth century. Fragments of his orations are printed in the "Papegyrici Veteres." Moreri.

**EUMENIA**, in *Ancient Geography*, a town of Asia, in the Greater Phrygia, seated on the Cludrus.—Also, a town of Asia Minor, in Caria.—Also, a town of Thrace, on the confines of Lower Mœsia.

**EUMENIDEIA**, *Ευμενιδαια*, an annual festival observed in honour of the Furies. It was otherwise called *σερμῶν ἑορτή*, because the Athenians called the Furies *σερμῶν θεῶν*, i. e. venerable goddesses.

**EUMENIDES**, in *Antiquity*. See **FURIES**.

**EUMETRES BELI**, in *Natural History*, the name given by the ancients to a gem which the Assyrians held sacred to their god, and which many other nations learned from them to suppose very powerful against magic. Many have supposed this to be the one we now call oculus Beli: but this is an error, since Pliny, in his account of the eumetres, says, that it was of a very fine green. It was probably a gem of the emerald kind, that stone having ever been in very high esteem in the Eastern part of the world, as it is also to this day.

**EUMINACUM**, in *Ancient Geography*, a town of Mœsia,

Mœsia, marked in the Itinerary of Antonine; 24 miles from Viminiacum,

EUMME' FAREGGE', or *Omm Faredje*, a canal of Egypt, joining lake Manzaleh with the Mediterranean; supposed to be the mouth of that ancient canal, called the Tanitic or Saitic branch of the Nile.

EUMOLPIDES, in *Antiquity*, priests of Ceres, who had the power among the Athenians of initiating into the mysteries of this goddess, or excluding from them.

EUMOLPUS, in *Biography*, a disciple of Orpheus, who, tracing the footsteps of his father Musæus, wrote concerning the mysteries of Ceres.

EUNAPIUS, a native of Sardis, in Lydia, flourished in the fourth century, and was a kinsman of the celebrated sophist Chrysanthius, at whose request he wrote the lives of the philosophers of his time. This work has been characterized by Brucker "as a mass of extravagant tales, discovering a feeble understanding, and an imagination prone to superstition;" besides being a sophist, he was an historian, and practised physic. In his writings he seems to have entertained a great prejudice against Christianity, the martyrs to which he treats with a contempt that has given just offence to contemporary ecclesiastical writers. He wrote a history of the Cæsars from Claudius II. to Arcadius and Honorius, of which only a fragment, "De Legationibus," is remaining. The "*Vitæ Philosophorum*" was published with a Latin translation by Junius in 1596. Moreri.

EUNILAK, in *Geography*, a place of East Greenland. N. lat. 61° 4'. W. long. 46°.

EUNOFIUS, a name given by some authors to the ætites, or eagle-stone.

EUNOMIANS, in *Ecclesiastical History*, a sect denominated from Eunomius, bishop of Cyzicus, who, in the fourth century, maintained most of the errors of Arius, and added others to them. He was a native of Dacora, a town of Cappadocia, and removing to Constantinople, gained his subsistence first as a notary, and afterwards as a school-master. At Alexandria he became a disciple of Aetius, whose opinions he adopted and strenuously defended. Having been ordained a deacon by Eudoxius, bishop of Antioch, he was deputed to the court of the emperor Constantius for the purpose of defending Eudoxius against the accusations of Basil, bishop of Ancyra; but in his way thither he was seized by the partizans of Basil, and banished to Myda, a city in Phrygia. In the year 360 he was ordained bishop of Cyzicus; but boldly avowing his opinions, he became obnoxious to the orthodox party, and underwent various and severe persecutions. At the command of the emperor Constantius, he was at length condemned and deposed by Eudoxius. At Chalcedon, whither he retired, his enemies pursued him, and he was afterwards banished by the emperor Valens to Mauritania. At the close of the reign of this emperor, after he had been allowed to return to Constantinople, he was charged with disturbing the peace of the church, and again banished to the island of Naxos. When Valens died, he returned to Chalcedon, but was soon sent into exile by the emperor Theodosius. Wearied by incessant and grievous persecution he obtained leave from the court to retire to the place of his nativity, where he died at an advanced age, about the year 394. He was the author of various works, most of which are now lost. Those that are extant are "Eunomius's Creed," presented to the emperor Theodosius in the year 383, and his "Apologeticus," or Defence of his Doctrine, in which, according to Dr. Cave, the sly arch-heretic reasons shrewdly. Fabricius has published this piece entire, and an English version of it may be seen in the 1st volume of Whiston's "*Primitive Christianity reviv-*

ed." Socrates Hist. Eccles. Cave's H. L. Fabr. Bib. Græc. vol. viii. Lardner.

EUNOMIËUPSYCHIANS, a sect of heretics of the fourth century, mentioned by Nicephorus, lib. xii. cap. 30. being the same with those called Eutychiens by Sozomen, lib. vii. cap. 17. See EUTYCHIANS.

EUNUCH, *Eunuchos*, a term applied in the general to all who have not the faculty of generating, either through imbecility or frigidity; but more particularly to such as have been castrated, or have lost some of the parts necessary for that purpose.

The word is formed of *εὐνοῦς*, q. d. *leili curam habet, guardian, or keeper of the bed.*

In England, France, &c. eunuchs are never made but on occasion of some disease which renders such an operation necessary; but in Italy they make eunuchs for the sake of preserving the voice; and in the East they make eunuchs to be guards or attendants on their women.

Great numbers of children, from one to three years of age, are yearly castrated in Italy to supply the operas and theatres, not only of Italy but other parts of Europe, with singers; though it is not one in three, that, after having lost their virility, have a good voice for a recompence. See CONSERVATORIOS.

Tavernier assures us, that in the kingdom of Boutan, in the East Indies, there are every year made twenty thousand eunuchs, and sold thence into other countries.

The seraglios of the Eastern emperors are chiefly served and guarded by eunuchs; and yet we have very good testimonies, that the rich eunuchs in Persia and other countries, keep seraglios for their own use. This is a punishment of crimes in some countries. See ADULTERY.

By an arret of the grand chamber of Paris in 1665, it is adjudged that an eunuch could not marry, not even with the consent of the woman, and all the parties on both sides.

Claudian has a very severe satire against the eunuch Eutropius, who had been elected consul of Rome. He represents him as an old woman, dressed up in the honours of the consulate.

In the council of Nice those were condemned who, out of an indiscreet zeal, and to guard themselves from sensual pleasures, should make themselves eunuchs. Such as thus mutilated their bodies were excluded from holy orders; witness Leontius, bishop of Antioch, who was deposed for having practised this cruelty on himself; and the bishop of Alexandria excommunicated two monks who had followed his example, on pretence of securing themselves from the impetuous motions of concupiscence.

Several of the emperors made very severe prohibitions against the making of eunuchs, or people's castrating themselves. See CASTRATION.

EUNUCHS, *Eunuchi*, in *Ecclesiastical History*, is also the denomination of a sect of heretics in the third century, who had the folly or madness to castrate not only those of their own persuasion, but even all they could lay hands on.

They took their rise from the example of Origen, who, upon a misunderstanding of our Saviour's words in St. Matthew, chap. xix. ver. 12. made himself an eunuch, by cutting off the offending part, as some say; or as others (particularly St. Epiphanius), by the use of certain medicines. These heretics were also called *Valesians*.

EVOCATI, among the Romans, soldiers, who having served their time in the army, went afterwards volunteers at the request of some favourite general.

EVOCATION, *Evocatio*, among the Romans, a religious ceremony always observed by them at undertaking  
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the siege of a town, wherein they solemnly called upon the gods and goddesses of the place to forsake it and come over to them. Without the performance of this ceremony, they either thought that the place could not be taken, or that it would be a sacrilege to take the gods prisoners.

The form of evocation used at taking the city of Carthage is related by Macrobius, Sat. III. 9.

They always took it for granted that their prayer was heard, and that the gods had deserted the place and came over to them, provided they were able to make themselves masters of it. The ancients had also two other sorts of evocation; one was a magical operation, which they used in order to call up departed souls. This custom of raising the manes, or conjuring up souls departed, was so ancient, that its origin is traced as high as the earliest periods of time; and all the anathemas denounced by the sacred authors against those who consulted familiar spirits are proofs of the antiquity of this practice. Among the different sorts of magic prohibited by Moses, that of calling up the dead is expressly specified. (See *WITCH* of *Endor*.) Prophane authors look upon Orpheus as the inventor of this art, in evidence of which it is alleged, that the hymns which are ascribed to him are mostly real pieces of conjuration, but it is probable that this practice was derived from the people of the East, and was carried into Greece with other religious ceremonies, by colonies which came and settled here. It is certain, however, that in the time of Homer, this sort of conjuration was practised, as it is mentioned in some passages of the *Iliad*. At that time it was not reckoned odious or criminal, since there were persons who made public profession of conjuring up ghosts, and there were temples where the ceremony of conjuration was to be performed. Pausanias (in *Beot.*) speaks of that which was in Thesprotia, where Orpheus came to call up the soul of his wife Eurydice. Ulysses's travels into the country of the Cimmerians, whither he went to consult the ghost of Tiresias, described by Homer in the *Odyssy* (l. xi.) seems to indicate a kind of conjuration. Historians, as well as poets, have mentioned this species of conjuration. Another sort of evocation was that which was used in calling up the gods. In order to understand this practice, it should be recollected, that it was a doctrine of the Pagan theology, that the gods presided in a peculiar manner over certain places, and that several of these places were under the protection of the same god; and as it was impossible for him to be in them all at the same time, it was necessary to use the ceremony of evocation, when his presence was thought needful. They had hymns proper to this operation, which they called *κλήσεις*, such as were most of those ascribed to Orpheus, and those of the poet Proclus. When they thought the patron god was arrived, they celebrated the festival named *επιδημιας*. As soon as the danger, which made them invoke the gods was passed, they gave them liberty to go any where else; and they had other hymns for celebrating their departure, which hymns were called *αποπερικσεις*.

**EVOCATORIÆ EPISTOLÆ**, among the Romans, letters sent by the emperors to command the attendance of any person; or letters granting licence to any one to wait on the emperor; every person not being allowed this privilege till they had desired and obtained the evocatoriæ epistolæ.

**EUODIA**, in *Botany*, from *ευωδια*, a sweet smell, Forst. Gen. 7. t. 7. See **FAGARA**.

**EVOLI**, in *Geography*, a town of Naples, in Principato Citra; 15 miles E.S.E. of Salerno.

**EVOLVENT**, in *Geometry*, a term which some writers

use for the curve resulting from the evolution of a curve: in contradistinction to the evolute, which is the curve supposed to be opened or evolved.

The evolute always both touches and cuts the evolvent at the same time; the reason is, that it has two of its infinitely small sides in common with the evolvent; or, rather exactly placed on two equal sides thereof; one of them within-side that of the evolvent, *i. e.* on the concave side thereof; and the other on the convex side of its correspondent side; so that the evolute touches the evolvent in two points; whence, instead of being a tangent, it is said to osculate the evolvent; and, hence, it is also called *osculator*, and *circulus osculator*.

There is one, and but one osculator, to each point of the evolvent; but to the same point there is an infinity of other circles which only touch, and do not osculate. The osculator, and the evolute, make no angle in the place where they touch and cut; nor can any curve line be drawn between, as there may between a tangent and a curve.

**EVOLUTE**, **EVOLUTA**, in the *Higher Geometry*, a curve first proposed by Mr. Huygens, and since much studied by the latter mathematicians. See **CURVATURE**.

The evolute is a curve, supposed to be evolved, or opened; and which, in opening, describes other curves.

To conceive its origin and formation, suppose a flexible thread, wound exactly over the convexity of any curve, as *ABCG* (*Plate VI. Analysis, fig. 1.*) and suppose the thread fixed in *G*, and every where else at liberty, to *A*. Now, beginning to unwind the thread from the point, and continuing it to *D*, and, throughout, keeping it tight on the curve surface *ABCG*, when the thread is become quite straight, and is only a tangent, *FG*, to the curve in the point *G*, it is evident the extremity *A*, in its progress to *F*, has described another curve line *ADEF*.

Here, the first curve *ABCG* is called the evolute; each of its tangents *BD*, *CE*, &c. comprehended between it and the curve *ADEF*, called the involute, is called a *radius of the evolute*, or *radius osculi*, *radius osculator*, or *radius of curvature*, of the curve *ADEF*, in the respective points *D*, *E*, &c. And the circles, whereof the osculators *BD*, *CE*, &c. are radii, are called *circuli osculatores* of the curve *ADEF*, in *D*, *E*, &c. And, lastly, the new curve resulting from the evolution of the first curve begun in *A*, is called the *curve of evolution*, or *curve described by evolution*.

**EVOLUTE**, *the radius of the*, then, is the part of the thread comprized between any point where it is a tangent to the evolute, and the correspondent point where it terminates in the new curve. Which appellation, *radius*, is the more proper, as one may actually consider this part of the thread in every step it takes, as if it described an arc of an infinitely small circle, making a part of the new curve, which thus consists of an infinite number of such arcs, all described from different centres, and with different radii.

Every curve, therefore, may be conceived as formed by the evolution of another. And we are to find that, whose evolution formed it; which amounts to the finding of the radius of the evolute in any point; for, as it is always a tangent to the generating curve, it is, properly, no more than one of its infinitely small parts, or sides, prolonged; and all its sides, whose positions are determined of course, are no other than the generating curve itself.

The same thread is also called *radius curvæ*, or *radius osculi*, because a circle described hereby, from the centre *G*, is said to osculate, or kiss it, as both touching and cutting at the same time, *i. e.* touching both the inside and the out.

Hence, 1. The evolute *BCF* (*fig. 35.*) is the place of

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all the centres of the circles that osculate the curve  $AM$ , described by evolution. 2. When the point  $B$  fall on  $A$ , the radius of curvature, or radius of the evolute,  $MC$ , is equal to the arc  $BC$ ; or to the aggregate of  $AB$ , and the arc  $BC$ . 3. Since the element of the arc  $Mm$ , in the curve described by evolution, is an arc of a circle described by the radius  $CM$ ; the radius of the evolute  $CM$  is perpendicular to the curve  $AM$ , or to a tangent at the point  $M$ . 4. Since the radius of the evolute  $MC$  is always a tangent to the evolute  $BCF$ , curves by evolution may be described through innumerable points, if only tangents be produced in the several points of the evolute, till they become equal to their correspondent arcs.

The finding of the radii of evolutes is a thing of great importance in the higher speculations of geometry; and even, sometimes, is of use in practice as the inventor of the whole theory, Huygens, has shewn, in applying it to the pendulum. (Horol. Oscill. part 3.) The doctrine of the oscula of evolutes is owing to M. Leibnitz, who first shewed the use of evolutes in the measuring of curves.

We shall here subjoin a brief account of the method of finding the radius of the evolute in different kinds of curves and equations expressing the nature of evolutes.

1. To form a general expression for  $(BE)$  the radius of the evolute, or of curvature at any point  $B$  in the involute curve  $ABY$ , whose axis is  $AX$ , and evolute  $DE$ , fig. 3.

With the radius  $EB$  describe the circular arc  $BK$ , which will have the same curvature with the involute curve  $AB$  at the point  $B$ . Draw the radius  $EK$  parallel to the axis  $AX$ , and produce the ordinate  $BC$  to  $L$ , to which draw  $AN$  parallel: let the absciss  $AC$  be  $= x$ , the ordinate  $CB = y$ , radius  $EB$  or  $EK = r$ ,  $KN = a$ , and  $NA = b$ ; then  $LE = r - a - x$ . If the absciss  $x$  be supposed to increase uniformly, and  $Bm$  to be a tangent at the point  $B$ ; and  $mn$  be drawn parallel to  $BC$ , and  $BN$  parallel to  $AX$ ;  $Bn, nm$ , and  $mB$ , which are the contemporary increments of the absciss, ordinate, and curve, will be as their fluxions respectively; or  $Bn$  will be as  $\dot{x}$ ,  $nm$  as  $\dot{y}$ , and  $Bm (= Bn^2 + nm^2)^{\frac{1}{2}}$  as  $\dot{x}^2 + \dot{y}^2$ .

Farther, the triangles  $Bnm$  and  $BLE$  are similar; therefore  $Bn : nm :: BL : LE$ , i. e.  $\dot{x} : \dot{y} :: y + b : r - a - x$ ; consequently,  $r\dot{x} - a\dot{x} - x\dot{x} = y\dot{y} + b\dot{y}$ : the fluxion of which equation (supposing  $\dot{x}$  invariable, and therefore, the direction of the curve  $AB$  continually approaching towards a parallelism with its axis, the fluxion of  $\dot{y}$  as negative) is  $-\dot{x}^2 = \dot{y}^2 - y\dot{y} - b\dot{y}$ ; and  $\dot{x}^2 + \dot{y}^2 = b + \dot{y} \times \dot{y}$ .

Again,  $LB : BE :: nB : Bm$ , i. e.  $b + y : r :: \dot{x} : \sqrt{\dot{x}^2 + \dot{y}^2}$ ; therefore  $b + y = \frac{r\dot{x}}{\dot{x}^2 + \dot{y}^2}$ , and substituting this expression for  $b + y$ , the above equation will become  $\dot{x}^2 + \dot{y}^2 = \frac{r\dot{x}\dot{y}}{\dot{x}^2 + \dot{y}^2}$ ; consequently,  $\dot{x}^2 + \dot{y}^2 \times \dot{x}^2 + \dot{y}^2 = r\dot{x}\dot{y}$ , i. e.  $\sqrt{\dot{x}^2 + \dot{y}^2} = r\dot{x}\dot{y}$ , and  $\frac{\dot{x}^2 + \dot{y}^2}{\dot{x}\dot{y}} = r = BE$ . In

deducing this expression, the increment of the ordinate  $y$ , or the velocity or fluxion with which it flows, is supposed continually to decrease, therefore its second fluxion is negative; but when  $y$  increases with an accelerated motion, its second fluxion will be affirmative; and the above expression will be  $\frac{\dot{x} - \dot{y}}{-\dot{x}\dot{y}}$ . By substituting 1 for  $\dot{x}$ , which is in-

variable in these expressions, they will become  $\frac{1 + \dot{y}^2}{\dot{y}}$

and  $\frac{1 - \dot{y}^2}{\dot{y}}$  respectively; the former taking place when

the curve is concave, and the latter when it is convex towards the axis, and the sign of  $\dot{y}$  shewing the position of the evolute and radius of curvature with respect to the curve and axis. By reducing these expressions from the nature and properties of the curve, and always substituting 1 for  $\dot{x}$ , we shall obtain the value of  $BE$ , or the radius required. The vertical distance or radius  $AD$  may be easily obtained by substituting for  $\dot{x}$ , 1, and for  $\dot{y}$  its proper value in the expression

for the subnormal  $CH$ , which is evidently  $\frac{y\dot{y}}{\dot{x}}$ . *E. gr.*

1. To find the radius of curvature at any point  $B$  in the parabola  $AY$ , fig. 4.

Let the parameter be  $= a$ , absciss  $AC = x$ , and ordinate  $CB = y$ : then, by the nature of the curve  $ax = y^2$ , and therefore  $a\dot{x} = 2y\dot{y}$  (see FLUXION), and making  $\dot{x} = 1$ ,  $a = 2y\dot{y}$ , and  $\dot{y} = \frac{a}{2y} = \frac{a}{2 \times ax}^{\frac{1}{2}}$ . But the fluxion of this

equation will be  $-\dot{y} = \frac{-a^{\frac{1}{2}}}{4 \times ax^{\frac{1}{2}}}$ , or  $\dot{y} = \frac{a^{\frac{1}{2}}}{4 \times ax^{\frac{1}{2}}}$ , and  $\dot{y}^2$  being equal to  $\frac{a^2}{4ax} = \frac{a}{4x}$ , we shall have, by substitut-

ing these values in the expression  $\frac{1 + \dot{y}^2}{\dot{y}}$  for  $\dot{y}^2$  and  $\dot{y}$ ,

$$\frac{1 + \frac{a}{4x}}{\frac{a^{\frac{1}{2}}}{4 \times ax^{\frac{1}{2}}}} = \frac{4}{a^{\frac{1}{2}}} \times \frac{4x + a}{4x} \times \frac{1}{ax^{\frac{1}{2}}} = \frac{4}{a^{\frac{1}{2}}} \times \frac{4ax^{\frac{1}{2}} + a^{\frac{1}{2}}x^{\frac{1}{2}}}{4x} = \frac{4}{a^{\frac{1}{2}}} \times \frac{1}{4} \times \frac{4ax + a^2}{4} = \frac{4ax + a^2}{2a^{\frac{1}{2}}}$$

Then if a semicircle be described through the point  $B$ ,  $Cn$  be bisected in  $H$ , and  $HR$  be made equal  $2AC$ , and  $RE$  be a perpendicular at  $r$ , produced till it meets a line  $BE$ , drawn from  $B$  through  $H$ , this line  $BE$  will be the radius of curvature required: for  $BC^2 = AC \times Cn$ , 35. E. 3. or  $\frac{AC}{BC} = Cn$ , i. e.  $\frac{ax}{x} = a = Cn$ , and  $CH = \frac{1}{2}a$ , and

$Cr = \frac{1}{2}a + 2x$ ; and by 47 E. 1.  $CH^2 + CB^2 = BH^2$ , i. e.  $\frac{1}{4}a^2 + ax = BH^2$ ; and by 4 E. 6.  $CH : HB :: Cr : BE$ ; i. e.  $\frac{1}{2}a : \frac{1}{2}a^2 + ax :: \frac{1}{2}a + 2x : \frac{a + 4x}{a}$

$\times \frac{a^2 + 4ax}{2a^2} = \frac{a^2 + 4ax}{2a^2} = BE$  as before.  $AD$  the vertical distance, or,  $\frac{y\dot{y}}{\dot{x}}$ , is in this case, putting  $\frac{a}{2y}$  for  $\dot{y}$ ,

and 1 for  $\dot{x}$ , equal to  $\frac{a}{2}$ ; and this likewise appears, by con-

sidering; that in the expression for the radius when the radius becomes equal to the vertical distance, the absciss  $x$  vanishes,

and it becomes  $\frac{a^2}{2a^2} = \frac{a^2}{2a^2} = \frac{a}{2}$ .

*E. gr.* 2. To find the radius of curvature at any point  $B$  in the cycloid  $ABD$ , fig. 5.

Put the radius  $OF$  or  $OD = a$ , absciss  $AC = x$ , ordi-

nate

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nate  $CB = y$ , sine  $IG = s$ , and arc  $FG = z$ . Now by 35 E. 3.  $IG = DI \times IF)^{\frac{1}{2}}$ , that is,  $s = \sqrt{2ay - y^2}^{\frac{1}{2}}$ ;

the fluxion of which equation is  $\dot{s} = \frac{ay - yy'}{2ay - y^2}^{\frac{1}{2}}$ ; and by the nature of the cycloid, arc  $DG = GB$ ; and therefore, arc  $FG = GI + AC$ , or  $AC = arc FG - GI$ , that is,  $z = z - s =$  (by substituting for  $s$  its above value)  $z - \sqrt{2ay - y^2}^{\frac{1}{2}}$ ; and the fluxion of this equation, making  $\dot{x} = 1$ , is  $\dot{z} = \dot{z} + \frac{yy' - ay}{2ay - y^2}^{\frac{1}{2}}$ .

But  $\dot{z} = \sqrt{s^2 + y^2}^{\frac{1}{2}} =$  (by writing for  $s$  its above value),

$$\frac{ay - y^2}{2ay - y^2}^{\frac{1}{2}} + y = \frac{ay}{2ay - y^2}^{\frac{1}{2}}; \text{ which, substituted}$$

for  $\dot{z}$ , makes the above equation  $1 = \frac{ay}{2ay - y^2}^{\frac{1}{2}} +$

$$\frac{yy' - ay}{2ay - y^2}^{\frac{1}{2}}; \text{ that is, } 1 = \frac{yy'}{2ay - y^2}^{\frac{1}{2}}; \text{ therefore, } y =$$

$\frac{2ay - y^2}{y^2}$ ; and the fluxion of this equation

(the fluxion of  $y$  being negative), is  $-\dot{y} =$

$$\frac{ay\dot{y} - y^2\dot{y}}{2ay - y^2}^{\frac{1}{2}} - \dot{y} \cdot \frac{2ay - y^2}{y^2}^{\frac{1}{2}} = \frac{-ay}{y^2} =$$

(by writing for  $\dot{y}$  its equal),  $-\frac{a}{y^2}$ ; that is,  $\dot{y} = \frac{a}{y^2}$ .

Now, by substituting  $\frac{2ay - y^2}{y^2}$  for  $y^2$ , and  $\frac{a}{y^2}$  for  $\dot{y}$ ,

$$1 + \frac{2ay - y^2}{y^2}^{\frac{3}{2}} \times \dot{y}^2 =$$

$$\text{we have } \frac{1 + \dot{y}^2}{\dot{y}} = \frac{1 + \frac{2ay - y^2}{y^2}^{\frac{3}{2}} \times \frac{a^2}{y^4}}{\frac{a}{y^2}} =$$

$$\frac{2ay}{ay} = \frac{2ay \times 2ay}{ay}^{\frac{1}{2}} = 2 \cdot 2ay^{\frac{1}{2}} = BE, \text{ the}$$

radius of curvature required.

*Construction.*—Make  $FH = GB$ ; and through the point  $H$  draw the right line  $BE$ , making  $BH = HE =$  chord  $FG$ ; then will  $BE$  be the radius of curvature at the point  $B$ ; for a tangent to the point  $B$  is parallel to the chord  $DG$ , and the radius of curvature is always perpendicular to the tangent; therefore, because by 31 E. 3. the  $\angle DGF$  is right,  $BE$  must be parallel to the chord  $FG$ . Now, by 4 and 8 E. 6.  $DF : FG :: GF : FI$ , or  $CB$ ,  $\therefore GF = DF \times CB)^{\frac{1}{2}} = 2ay)^{\frac{1}{2}}$ , and  $2GF = 2 \cdot 2ay)^{\frac{1}{2}} = BE$ .

2. To form a general expression for the radius of curvature in spirals, or curves whose ordinates are referred to a fixed or central point:

Let  $CBY$ , (*fig. 6.*) be the curve,  $C$  the central point, or that from which all the ordinates issue; and  $BE$  the radius of the curvature at the point  $B$ , that is, let the point  $E$  be supposed in the evolute curve: conceive  $Cb$  and  $Eb$  indefinitely near to  $CB$  and  $EB$ , that is, let the points  $B$  and  $b$  be supposed indefinitely near to each other; and let  $Cf$  and  $Cf'$  be perpendicular to  $EB$  and  $Eb$  respectively, then will the points  $F$  and  $f$  be indefinitely near to a coincidence; and therefore  $Bf$  and  $Cf$  may be taken as equal to  $Bf$  and  $Cf$ . Now, if, with the

ordinate  $CB$  as a radius, the little circular arc  $Bn$  be described and considered as a little right line perpendicular to  $Cb$ , and the increment  $Bb$  be considered as coinciding with the tangent to the point  $B$ , then the little right-angled triangle  $Bnb$  will be similar to the right-angled triangle  $BFC$ ; (for  $\angle CBn = \angle EBb$ ; and therefore  $\angle EBn$  being common, the  $\angle CBF = \angle nBb$ ; and, consequently, the angles at  $F$  and  $n$  being right,  $\angle BCF = \angle Bbn$ ); therefore by 4 E. 6.  $bB : Bn :: CB : BF$ ; that is, (if we put the ordinate  $CB = y$ ,  $Bn = x'$ , and  $nb = y'$ , when, by 47 E. 1  $Bb$

will be  $= \sqrt{x'^2 + y'^2}$ ),  $x' : y :: y : \frac{x'y}{\sqrt{x'^2 + y'^2}}$

$= BF$  or  $Bf$ ; and  $Bb : bn :: BC : CF$ , that is,

$$\sqrt{x'^2 + y'^2}^{\frac{1}{2}} : y' :: y : \frac{yy'}{\sqrt{x'^2 + y'^2}} = CF$$
 or  $Cf$ ; the increment of which is  $rf$ ; that is, supposing  $x'$  to be invariable)  $\frac{y' \dot{y}}{x'^2 + y'^2}^{\frac{1}{2}} - y' y' \times \frac{y y'}{x'^2 + y'^2}^{\frac{1}{2}} =$

$$\frac{x'^2 y'^2 + y'^4 + y x'^2 y''}{x'^2 + y'^2}^{\frac{3}{2}} = rf.$$
 Again, the triangles

$E B b$  and  $E r f$  being similar,  $Bb - rf : Bb :: (BE - rE, \text{ or } rB : BE$ ; that is,  $(\frac{x'^2 + y'^2}{x'^2 + y'^2})^{\frac{1}{2}} -$

$$\frac{x'^2 y'^2 + y'^4 + y x'^2 y''}{x'^2 + y'^2}^{\frac{3}{2}} = \frac{x'y}{x'^2 + y'^2}^{\frac{1}{2}} : \frac{y \cdot x' + y^2}{x'^2 + y'^2}^{\frac{3}{2}}$$

$= BE$ , or  $BE = \frac{y \times x' + y^2}{x'^2 + y'^2}^{\frac{3}{2}}$ ; which is a general expression for the radius of curvature of all curves referred to a fixed or central point, when  $x'$  or  $\dot{x}$  is invariable.

Hence, if  $\dot{x}$  be made  $= 1$ , the general expression for the radius of curvature will be  $= \frac{y \times 1 + \dot{y}^2}{1 + \dot{y}^2 - y\ddot{y}}$ . Wherefore, if we put the equation of the given spiral into fluxions, making  $\dot{x} = 1$ , and put this fluxional equation into fluxions again; and from thence, or from the nature of the curve, find the values of  $\dot{y}^2$  and  $\ddot{y}$ ; then, if for  $\dot{y}^2$  and  $\ddot{y}$  we substitute these their values in this general expression, we shall have  $BE$  the radius of curvature required.

Otherwise. Let  $ARB$  be the proposed curve, (*fig. 7.*)  $P$  the point, or centre, to which its ordinates are referred.  $NOL$  the evolute, and  $RO$  the ray of curvature at  $R$ . Moreover, let  $PH$  be perpendicular to  $RO$ ; and supposing the ordinate  $PR$  ( $y$ ) to become variable by the motion of the point  $R$  along the curve, let the fluxions of  $A R$  and  $P H$  ( $\rho$ ), expressing the celerities of the points  $R$  and  $H$  in directions perpendicular to  $RO$ , be denoted by  $\dot{z}$  and  $\dot{\rho}$  respectively: the fluxions of quantities being always as the celerities by which the quantities themselves increase in magnitude. (See FLUXION).

Therefore the celerities of any two points, in a right line revolving about a centre, being as the distances from that centre, it follows that  $\dot{\rho} : \dot{z} :: OH : OR$ ; whence by division (putting  $RH = v$ ) we have  $\dot{z} - \dot{\rho} : \dot{z} :: v - (RH) : RO = \frac{v\dot{z}}{\dot{z} - \dot{\rho}} = \frac{v\rho\dot{z}}{\rho\dot{z} - \dot{\rho}^2}$ . But  $\dot{\rho} \cdot \dot{z} = y \cdot \dot{y}$ .

and

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and therefore  $RO = \frac{vyj}{yy - p\dot{p}}$ ; which, because  $y^2 - p^2$  is  $v^2$  (and therefore  $y\dot{y} - p\dot{p} = v\dot{v}$ ) will also be  $= \frac{vyj}{v\dot{v}} = \frac{yj}{\dot{v}}$ .

*E. G. 1.* Let the given curve  $AR$  (*fig. 7.*) be the logarithmic spiral, whose nature is such, that the angle  $PRQ$  (or  $RPH$ ) which the ordinate makes with the curve, is every where the same.

Then (denoting the sine of that angle by  $b$ , and the radius of the tables by  $a$ ) we have  $RH(v) = \frac{by}{a}$ , and

therefore  $RO\left(\frac{y\dot{y}}{v}\right) = \frac{ayj}{by} = \frac{ay}{b}$ ; which being to  $PR$

( $y$ ) in the constant ratio of  $a$  to  $b$ , or of  $PR$  to  $RH$ , the triangles  $ROP$  and  $RPH$  must therefore be similar, and so the angle  $POH$ , which the ordinate  $PO$  makes with the evolute, being every where equal to  $PRQ$ , will likewise be invariable. Whence it appears that the evolute is also a logarithmic spiral, similar to the involute; and that a right line drawn from the centre, perpendicular to the ordinate of any logarithmic spiral, will pass through the centre of curvature.

*E. G. 2.* To find the radius of curvature at any point  $B$  the spiral of Archimedes,  $CB$ , &c. *fig. 8.*

Put the circumference of the generating circle  $AF$ , &c.  $= a$ , and its radius  $CA = b$ , ordinate  $CB = y$ , arc  $AF = z$ . Let  $Cf$  be supposed indefinitely near to  $CF$ , that is, let the  $\angle FCf$  be supposed indefinitely small; and with the ordinate  $CB$  as a radius describe the little circular arc  $Bn$ , which put  $= x'$ ; also put  $Ff = z'$ . Now, by the nature of the curve,  $a : b :: z : y$ , or  $z = \frac{ay}{b}$ , the fluxion of which equation is  $\dot{z} = \frac{a\dot{y}}{b}$ ; and by the similar sectors  $CBn$  and  $CFf$ ,  $y : x' :: b : z' = \frac{bx'}{y}$ , or,  $\dot{z} = \frac{b\dot{x}'}{y}$ . Hence,  $\frac{a\dot{y}}{b} = \frac{b\dot{x}'}{y}$ ; that is, (making  $\dot{x} = 1$ )  $\frac{a\dot{y}}{b} = \frac{b}{y}$ ; from which equation we have

$$j = \frac{b^2}{ay}; \text{ therefore } j^2 = \frac{b^4}{a^2y^2}, \text{ and } \dot{j} = \frac{-ab^2\dot{y}}{a^2y^3} =$$

(by writing for  $j^2$  its value),  $\frac{-b^4}{a^2y^2}$ ; and if we substitute

for  $j^2$  and  $\dot{j}$  these their values, we shall have  $\frac{y \times 1 + \dot{y} \times \frac{1}{2}}{1 + y^2 - yj}$

$$= \frac{y \times 1 + \frac{b^4}{a^2y^2}}{1 + \frac{b^4}{a^2y^2} + \frac{b^4}{a^2y^2}} = \frac{ay^2 + b^4}{a^2y^2 + 2ab^2} = BE, \text{ the radius of curvature sought.}$$

*Construction.*—Through the centre  $C$  draw the indefinite right line  $Hv$  perpendicular to the ordinate  $CB$ ; draw the tangent  $TB$ , perpendicular to which draw  $BH$ ; produce  $BC$  to  $V$ , making  $BR = TH$  and  $RV = CH$ ; with  $BV$  and  $BR$  as radii, describe the arcs  $Vv$  and  $Rr$ ; draw the right line  $vB$ ; and from the intersecting point  $r$  draw  $rE$  parallel to  $vH$ ; then will  $BE$  be the radius of curvature at the point  $B$ : for,  $CT = \frac{y\dot{z}}{b}$ , that is, by substituting  $\frac{ay}{b}$  for  $z$ ,  $CT$

$= \frac{ay^2}{b^2}$ ; and by 8 and 4 E. 6.  $TC : CB :: CB : CH$ , that is,  $\frac{ay^2}{b^2} : y :: y : a = CH$ ; therefore  $TH = BR = Br = \frac{ay^2}{b^2} + \frac{b^2}{a}$ , and  $BV = Bv = \frac{ay^2}{b^2} + \frac{2b^2}{a}$ ; and by 47 E. 1.  $HB = \sqrt{BC^2 + CH^2} \times \frac{1}{2} = \sqrt{b^2 + \frac{a^2y^4}{b^2}} \times \frac{1}{2} = \frac{a^2y^2 + b^2}{a}$ ; again, by 4 E. 6.  $Bv : BH :: Br : BE$ , that is,  $\frac{ay^2}{b^2} + \frac{2b^2}{a} : \frac{a^2y^2 + b^2}{a} :: \frac{ay^2}{b^2} + \frac{b^2}{a} : \frac{a^2y^2 + b^4}{a^2y^2 + 2b^2} = \frac{a^2y^2 + b^4}{a^2y^2 + 2ab^2} = BE$ .

3. To find an equation that shall express the nature of the evolute of a given involute curve.

Let  $BE$  be the radius of evolution or curvature at any point  $B$  in the involute curve  $AB$ , *fig. 9.* whose absciss is  $AC = x$ , and ordinate  $CB = y$ . Parallel to  $HA$  draw  $EN$ ; produce  $BC$  to  $L$ ; and equal and parallel to  $CL$ , draw  $DN$  from the vertex of the evolute  $DE$ ; then will the triangles  $BHC$  and  $BEL$  be similar: and therefore, by 4 E. 6.  $BH : HC :: BE :$

$EL$ , that is,  $\frac{\dot{y}}{x} \times \sqrt{x^2 + y^2} \times \frac{1}{2} : \frac{y\dot{y}}{x} :: \frac{x^2 + y^2}{x\dot{y}} : \dot{y}$

$\times \frac{x^2 + y^2}{x\dot{y}} = EL$ ; and  $HC : CB :: EL : LB$ , that

is,  $\frac{y\dot{y}}{x} : y :: \dot{y} \times \frac{x^2 + y^2}{x\dot{y}} : \frac{x^2 + y^2}{\dot{y}} = LB$ . Now, these are general expressions for  $EL$  and  $LB$ , when  $\dot{x}$  is considered as invariable, and the fluxion of  $y$  as negative. Hence, therefore,

If  $\dot{x} = 1$ , and the fluxion of  $y$  be negative, the general expression for  $BL$  will be  $= \frac{1 + j^2}{j}$ , and this multi-

plied by  $\dot{y}$  is  $\dot{y} \times \frac{1 + j^2}{j} =$  the general expression for

$LE$ . Now, by help of the equation of the given involute curve, exterminate  $j$ ,  $j^2$ , and  $\dot{y}$ , out of these expressions, and find the vertical distance  $AD$ . Then, if we put the absciss of the evolute  $DN = u$ , and its ordinate  $NE = v$ ; by help of these two equations,  $u = BL - BC$ , and  $v = AC - AD + LE$ , we may get the nature of the evolute curve  $DE$  required.

*Note.*—If the given involute be convex towards its axis, and  $x$  and  $y$  increase together, or the fluxions of  $x$  and  $y$  be both affirmative, then the general expressions for  $BL$  and  $LE$  will be  $\frac{1 + j^2}{-j}$ ; and  $\dot{y} \times \frac{1 + j^2}{-j}$  respectively; wherein the negative sign shews, that the points  $L$  and  $E$  must be taken on the concave side of the involute curve, that is, on the other side of it with regard to  $x$  and  $y$ .

*E. gr.* To find the nature of the curve  $AEP$  (*fig. 10.*) by whose evolution the cycloid  $ABD$  is described.

Put  $AC = x$ ,  $CB = y$ , arc  $FG = z$ , and  $OD$  or  $OF = a$ ; then by Ex. 2. art. 1. above,  $j = \frac{2ay - y^2}{y}$   
 $j^2 = \frac{2ay - y^2}{y^2}$ , and  $\dot{y} = \frac{a}{y}$ ; wherefore,  $BL =$

$$\frac{x + y^2}{y} = \frac{1 + \frac{2ay - y^2}{y^2} \times y^2}{a} = 2y, \text{ and } LE = y \times$$

$$BL = \frac{2ay - y^2}{y} \times 2y = 2 \cdot 2ay - y^2 \frac{1}{2}. \text{ Hence, if}$$

we put the absciss AN = u, and ordinate NE = v, we have u ( = BL - CB = ) 2y - y = y, and v = ( AC + LE = ) x + 2 \cdot \frac{2ay - y^2}{y^2} \frac{1}{2} that is, (because x = z - \frac{2ay - y^2}{y^2} \frac{1}{2}) v = z + \frac{2ay - y^2}{y^2} \frac{1}{2}, or, (writing u for y its equal,) v = z + \frac{2au - u^2}{u^2} \frac{1}{2}. Wherefore, the evolute curve AEP is a cycloid, and equal to the given cycloid ABD; for, let AS = SV = a, then (AN being = FI,) AT' = FG = z, and NT' = \frac{2au - u^2}{u^2} \frac{1}{2} = IG; and therefore, AT' + TN = z + \frac{2au - u^2}{u^2} \frac{1}{2}, that is, AT' + TN = NE, which is the property of the cycloid; therefore, the evolute AEP is a cycloid; and because AV = FD, therefore the cycloids AEP and ABD are equal. See CYCLOID.

The evolute of a spiral, or indeed of any other curve, may be described by finding the radii of curvature at several points in the involute; for then we shall have as many points in the evolute, through which if a curve line be drawn, it will be the evolute sought.

Wolf. Elem. Math. tom. i. p. 524, seq. or the Infinim. Petites of M. le Marquis de l'Hopital. Simpson's Fluxions, vol. i. p. 71, &c. And Rowe's Fluxions, edit. 3. 1767, chap. vi. and vii. p. 103-132.

Since the radius of an evolute is either equal to an arc of an evolute, or exceeds it by some given quantity, all the arcs of evolutes may be rectified geometrically, whose radii may be exhibited by geometrical constructions; whence we see why an arc of a cycloid is double its chord; the radius of the evolute being double the same, and the evolute of a cycloid being itself a cycloid, equal and similar to the involute.

M. Varignon has applied the doctrine of the radius of the evolute to that of central forces; so that having the radius of the evolute of any curve, one may find the value of the central force of a body; which, moving in that curve, is found in the same point where that radius terminates; or reciprocally, having the central force given, the radius of evolute may be determined. Hist. de l'Acad. Roy. des Sciences, an. 1706.

The variation of curvature of the line described by the evolution of a curve, is measured by the ratio of the radius of curvature of the evolute, to the radius of curvature of the line described by the evolution. See Maclaurin's Flux. art. 402. prop. 36.

EVOLUTE, imperfect. M. Reaumur has given a new kind of evolute, under this denomination. Hitherto the mathematicians had only considered the perpendiculars let fall on the points of the convex side of the curve; if other lines not perpendicular were drawn upon the same points, provided they were all drawn under the same angle, the effect would be the same; that is, the oblique lines would all intersect within the curve; and by their intersections, form the infinitely small side of a new curve, whereof they would be so many tangents.

This curve would be a sort of evolute; and would have its radii; but an imperfect evolute, since the radii are not perpendicular to the first curve. Hist. de l'Acad. &c. an. 1709.

EVOLUTION, in Geometry, the unfolding or opening of a curve, and making it describe an évolvent.

The word *evolutio* is formed of the preposition *e*, out, and *volvo*, I roll, or wind; q. d. an *unwinding*, or *unrolling*.

The equable evolution of the periphery of a circle, or other curve, is such a gradual approach of the circumference to rectitude, as that its parts do all concur, and equally evolve, or unbend; so that the same line becomes successively a less arc of a reciprocally greater circle, till at last they change into a straight line. In the Philosophical Transactions, N<sup>o</sup> 260, a new quadratrix to the circle is found by this means, being the curve described by the equable evolution of its periphery.

EVOLUTION, in Algebra, is also used for the extraction of roots out of powers. In which sense it stands opposed to involution. See EXTRACTION of roots.

EVOLUTION, as relating to Military operations, must be understood to be founded on the principles of TACTICS (which see), and be considered indispensably necessary to the safety, the progress, and the success of all bodies of men, whether large or small. The term is generally used as synonymous with manœuvre, but in strictness they are by no means to be so accounted; for an evolution rather relates to an open, candid, and undisguised movement, made either for a change of position, or for the general purposes of attack and defence; while a manœuvre applies abstractedly to deceptive movements, to feints, and to that kind of trick which gives rise to the saying so common among us, "I have out-manœuvred him." Thus the French, from whom we have directly borrowed the term, say, "un rusé manœuvre," i. e. a cunning fellow; and among them a skilful seaman is designated "un manœuvrier."

In every service, both in the military and naval departments, certain regulations exist which direct, that all candidates for promotion should be acquainted, not simply with the several motions of the firelock, and the ordinary duties of individuals, but with a variety of movements to be made by entire battalions, or armies, and by either single ships, squadrons, divisions, or fleets respectively. It being our intention to amplify under the head of TACTICS, military and naval, we shall in this place confine ourselves to those evolutions which, forming a part of the British discipline, ought to be thoroughly understood by every person whose pursuits tend towards the goal of martial celebrity; and should be thoroughly understood by every officer, of whatever rank.

The following nineteen changes will be sufficient for the purpose, under the remark, that we presuppose a battalion to be arranged at close order, and all in readiness for performing the required evolutions.

Evolution 1.

On a rear division.	{	Form close column of companies behind grenadiers.	Explanation.—The column marches quick, 20 or 30 paces to the right, and, without halting, begins to deploy into line on the rear division. The commanding officer of the battalion gives the word, for each division to halt, front.
		Form close column of two companies.	
		Face and march to the right.	
		Deploy on the rear division.	

Evolution 2.

On a front division.	{	Form close column of companies in front of the left.	The column marches quick, 30 or 40 paces to the left, and, without halting, begins to deploy on the front division. The commanding officer of the battalion gives the word for each division to halt, front.
		Form close column of two companies.	
		Face and march to the left.	
		Deploy on the front division.	

# EVOLUTION.

## Evolution 3.

On a central division.

Form close column of companies on a central company, either flank in front, and facing to the rear. Countermarch of each division in close column. Deploy on any central named company.

The close column is formed facing to the rear. It then countermarches each division, so as to return to the proper front. In the central deployment by companies, the company officers give the words respectively to halt, front.

## Evolution 4.

Change of position in open column.

Wheel back into open column of companies, the right in front. March forward 30 or 40 paces. Enter an oblique line (the three or four leading companies), by wheeling successively to the left, a half-wheel. Halt. The rear companies file into column. Wheel up into line.

The battalion, thus, at an intermediate point, enters an alignment, on which it is to form.

## Evolution 5.

Wing thrown back.

The left company is wheeled back till parallel with the original position. The rest of the companies wheel into echelon. March to the rear. Form on the left company.

The whole companies wheel back at the same time; the left company twice the number of paces that the others do. Should it be necessary for the subsequent movements, the line may retire 50 or 60 paces, and then front.

## Evolution 6.

Countermarch, and change of position.

Wheel back into open column, the right in front. Countermarch companies by files. March in column 30 or 40 paces. Head division halts close to the head of column. Form square, and prepare for firing. Re-form in close column. Open out to open column from the rear, and halt. Change head of column, by the countermarch of companies, from the rear to the front. Column moves on and halts. Wheel up into line.

After the countermarch by files, the column stands with its left in front. The column closes in quick time. The square is formed, and close column re-formed. The column opens out in quick time from its rear division, and halts. The countermarch by companies, from the rear to the front, is in ordinary time. When the line is formed, it is then considerably to the reviewing general's right, and with its rear to him.

## Evolution 7.

Countermarch by files on the centre of the battalion. This brings back the battalion to its original front.

## Evolution 8.

March in open column.

Form open column behind the left company, which is put in march when the third company has taken its place in column. The right sub-divisions double. The column halts, and pivots are corrected. Wheel up into line.

The companies that are filing incline towards the head of the column; successively front at their wheeling distances, ascertained as usual by their sergeants; take up the ordinary step, and follow in open column. When the column is marching steadily, the whole sub-divisions double at once, at one command, and again move up at another.

## Evolution 9.

Echelon change of position.

Wheel back into open column, the left in front. The third company is wheeled back, the 8th of a circle, and each of the others 3-16ths of the circle. Form line on the third company by the echelon-march.

The line is thus formed oblique, from open column, on a central company, by the echelon-march.

## Evolution 10.

Change of position.

The left company is wheeled up the 8th of a circle, and each of the others 1-16th. Form line by the echelon-march.

The line thus changes position to the front, on the left company, by the echelon-march.

## Evolution 11.

Change of position.

The battalion faces to the right. March in file 50 or 60 paces. Halts. Wheels up into line, except the light company, which files quickly to the right, and forms behind the colours.

The column of companies is formed by the rear men of each moving up quickly to the left of their leaders, and of each other: the officers move to pivot flanks, and pivots are instantly corrected. The column halts when the colours are opposite to the general.

## Evolution 12.

Retreat in line.

The battalion retires (50 paces). Halts; fronts. Fire twice by companies from centre to flanks. Retreat by alternate companies in two lines (250 paces, each retreat about 50 paces.) Form line. Retreat in line (50 paces). Halt; front.

The light company, being previously subdivided and prepared, acts in the retreat by alternate companies, filling up, or at least occupying the intervals in the first line, and retiring with it to the second, in which it continues to set in like manner, and thus alternately. When the line halts, and fronts, it resumes its place on the left.

Evolution 13.

March to flank in echelon.

Companies make a half wheel to the right. March in echelon, (250 paces.) Wheel back on the march into parallel line. Forward (100 paces.) Halt. Fire thrice by companies, from flanks to centre.

At the word "wheel back intoline," the pivot flanks mark time, and the divisions wheel back in ordinary time. At the proper instant, when the battalion is formed, the commander gives the word "Forward." for the whole to advance by the colours, and to correct any irregularity there may be in the battalion.

[Hitherto the battalion may have been *two* deep, but if its companies can muster ten files each, the corps may now be formed *three* deep.]

Evolution 14.

Movements in the square.

Form square. March the square by the left. Angle of the front face (50 paces.) Halt; form square. March square by the left face. Halt; form square. March square by the rear face. Halt; form square. Fire in square by companies. Form the line.

The square is formed by the echelon march of companies. After the march by the left face, the square is formed when opposite the general. The line is formed by the echelon wheel-up, and march of companies. When the order is given to form line, the light company marches quickly, and places itself two deep, and in two divisions, ten or twelve paces behind the two centre companies.

Evolution 15.

Retiring, and filing to the rear.

Retire in line (100 paces.) File by companies from the proper right. Halt in open column, the right in front. Wheel up into line.

When the line has passed the light company twenty paces, that company extends to cover the centre of the battalion, and follows at 50 or 60 paces distance; and when the column halts to form, the light company passes quickly through and beyond it. The companies file quickly to the rear.

The battalion forms line at the extremity of its ground; the light company 30 paces in its rear.

Evolution 16.

Fire, marching and changing to the front.

Advance in line (50 paces.) File from the right of companies to the front (50 paces.) Halt in open column, the left in front. Wheel up into line. Advance in line (50 paces.) Advance by alternate half battalions, and fire four times.

Before the line advances, the light company quickly forms, extended 30 paces before the centre, and preserves that distance in advancing. When the column halts to form, the light company passes quickly to the rear, and assembles half of it behind each flank, then moves relatively with the flank-companies, till after the charge of bayonets. The alternate half-battalions fire, the two first ranks standing.

Evolution 17.

Charge and pursuit.

Form line. Advance (50 paces.) Fire volley. Advance (50 paces.) Fire volley. Charge bayonets (50 paces.) Halt. Load.

After the volley, bayonets are ported; the battalion advances firm by the centre at the quick step, and at the word "Halt," the front rank comes down to the charging position. The word "Prime and Load" is then given, and the light company, issuing from behind the flanks, pursue, return, and assemble, and join on the left of the battalion.

Evolution 18.

Retiring in line.

Retire in line (100 paces.) Retire by alternate half battalions. Fire four times. Retire in line (100 paces, or more.) Halt. Front.

The whole battalion being assembled, the alternate half-battalions fire, the two front ranks standing.

Evolution 19.

Advance in line and salute.

Advance in line (100 paces.) Halt. Fire two volleys. Port arms at the last one, and half cock. Open ranks. Advance within 50 paces of reviewing general. Halt. General salute.

In the volleys the front rank kneels. The music may occasionally play, and the drums roll, as the line advances. The music will play while advancing at open ranks.

We have selected this portion of the discipline ordered for the British army, because it comprizes sufficient changes to give our readers a correct idea of what are termed *evolutions*. These are so contrived as to be performed on a very moderate extent of ground; each evolution serving to correct any obliquity, or lateral change of position, and confining the regiment within certain limits.

It may be proper to remark, that though the foregoing relate in this instance to a single regiment under review, the whole of the charges may be considered as representing those made by a large army; the several companies being the representatives of regiments, or of larger bodies. See BATTALION.

Fa. Holte, a Jesuit, in 1697, printed a Treatise on Naval Evolutions, in folio. By naval evolutions he means the motions made by a fleet, squadron, or naval armament, in order to put themselves in a proper disposition for attacking the enemy, or defending themselves with the most advantage. See TACTICS.

EVOLVULUS, in Botany, from *evolvo*, to roll out or unfold, in opposition to *Convolutulus*, with which the present genus agrees in habit, except in not having a convoluted stem. Linn. Gen. 152. Schreb. 204. Willd. Sp. Pl. v. 1. 1516. Juss. 134. Class and order, *Pentandria Tetragynia*. Nat. Ord. *Campanacea*, Linn. *Convolutuli*, Juss.

Gen. Ch. *Cal.* Perianth inferior, of five lanceolate, acute, permanent segments. *Cor.* of one petal, regular, wheel-shaped, plaited, slightly five-cleft. *Stam.* Filaments five, capillary, spreading, almost as long as the corolla; anthers rather oblong. *Pist.* Germen superior, nearly globular; styles four, capillary, spreading, the length of the stamens; stigmas

simple. *Peric.* Capsule nearly globular, of four cells and four valves. *Seeds* solitary, roundish, angular on the inner side.

*Eff. Ch.* Calyx of five leaves. Corolla five-cleft, wheel-shaped. Capsule superior, of four cells. *Seeds* solitary.

Willdenow has seven species, five of which were known to Linnæus. Among the latter is *E. linifolius*, Linn. Sp. Pl. 392. (*Convolvulus linifolius*; Am. Acad. v. 4. 306. Sytt. Nat. ed. 10. v. 2. 923. Brown. Jam. t. 10. f. 2.) whence he informs us he derived the above generic character, having the plant alive under his own inspection. It is a small inconspicuous annual, with slender, straight, spreading stems; narrow, lanceolate, hairy leaves; and little, blue, axillary flowers; native of low ground in Jamaica.

The other species have rounder leaves, but otherwise agree very much with the above. They grow in the East or West Indies, and are annuals of humble growth, and no conspicuous attractions, being inferior in beauty to the meanest species of *Convolvulus*.

*E. tridentatus*, Linn. Sp. Pl. 392, is now returned to *Convolvulus*, see that genus, sp. 19.

**EUONYMUS**, *εὐώνυμος* of Theophrastus, so called by antiphrasis, from *εὐώνυμος*, having a good name, because the plant was infamous for its strong fœtid smell, and its poisonous quality to cattle. Spindle-tree. Linn. Gen. 107. Schreb. 148. Willd. Sp. Pl. v. 1. 1130. Juss. 377. Gærtn. t. 113. Class and order, *Pentandria Monogynia*. Nat. Ord. *Dumoseæ*, Linn. *Rhamnii*, Juss.

*Gen. Ch.* Cal. Perianth inferior, flat, in four or five deep, equal, roundish, concave segments. *Cor.* Petals four or five, ovate-oblong, flat, spreading, longer than the calyx. *Stam.* Filaments four or five, awl-shaped, erect, shorter than the petals, inserted, alternately with them, into a glandular receptacle; anthers two-lobed. *Pist.* Germen superior, pointed; style short, simple; stigma obtuse. *Peric.* Capsule succulent, coloured, depressed, with four or five angles, and as many cells and valves. *Seeds* solitary, ovate, each wrapped up in a pulpy arillus.

*Eff. Ch.* Calyx flat. Petals five. Capsule superior, five-sided, coloured, of five cells and five valves. *Seeds* in a pulpy covering.

A genus of extra-tropical shrubs, the produce of Europe, North America and Japan. Willdenow has seven species. They are destitute of hairiness, and have opposite branches and leaves; the latter simple, deciduous, more or less elliptical, entire or toothed, with scarcely any stipulas. Flowers of a dull or greenish hue, in axillary forked panicles, not ornamental. Fruit much more conspicuous and often very beautiful, on account of the pink, waxy hue of the capsule, varying occasionally to white, and orange coverings of the seeds.

*E. Tobira*. Thunb. Jap. 99. (Tobira; Kæmpf. Am. Exot. 796, cum ic.), a native of Japan, has terminal flowers, and in many other respects seems not perfectly to accord with this genus.

*E. europæus*. Sm. Fl. Brit. 262. Engl. Bot. t. 362; and *E. verrucosus*, Jacq. Austr. t. 49; also *E. latifolius*, Jacq. Austr. t. 289; are good examples of it. Linnæus confounded them together as varieties, but Scopoli, and afterwards Jacquin, have well distinguished them. The last species in particular is very remarkable for its warty branches, slender habit, reddish flowers, and small pale capsules, out of which the black seeds, partially clothed with their scarlet arillus, hang by slender threads. The wood of all of them is tough, and used for skewers and spindles. It should be cut in the summer. The fruit serves in many places to decorate churches and rustic kitchens at Christmas-

time. It is reported to be dangerously emetic and purgative.

**EUONYMUS**, in *Gardening*, comprehends plants of the hardy flowering shrubby kind, of which the species cultivated are, the common spindle-tree (*E. europæus*); the warted spindle-tree (*E. verrucosus*); the purple-flowered spindle-tree (*E. atropurpureus*); the ever-green spindle-tree (*E. americanus*); and the broad-leaved spindle-tree (*E. latifolius*.)

The evergreen sort of spindle tree has a variety with variegated leaves.

*Method of Culture*.—All the four more common sorts may be propagated either by seeds, layers, or cuttings of the young shoots; but the evergreen kind requires a different method.

In the first mode, the seeds should be sown in the clumps or borders in the early autumn, covering them well in: In the following autumn the plants should be removed, and set out in nursery rows, being kept well cleared from weeds during the summer. After two or three years growth in this situation, they will be fit to plant out for good, in proper situations.

With respect to the young shoots, they may be laid down in the autumn, a slit being made at the joint placed the deepest in the ground. In the following autumn they will be well rooted, and may be taken off and planted out in the manner of the seedling plants.

The cuttings should be made eight or ten inches in length, and planted in a shady border in the autumn. When they have struck full root, they should be carefully removed, and managed as those raised from the seed.

But the two last methods, and those of budding and grafting, are the only ones by which the green variety can be continued with certainty and success.

With regard to the last species, it is best increased by laying down the young branches after being tongued in the autumn, managing them afterwards in the same manner as the others.

These plants are sufficiently hardy to bear the open air, when planted in warm sheltered situations.

They are all very ornamental plants; the four common sorts producing a fine effect by their berry-like seeds, and the last sort but one by its evergreen leaves; the chief objection to the former kinds being their great aptitude to have their leaves completely eaten up by the caterpillars soon after they are fully expanded.

**EVORA**, or **ELVORA**, anciently *Ebora*, in *Geography*, an ancient, walled and fortified, large but not populous, city of Portugal, the capital of the province of Alentejo, and an archbishop's see, situated on a gentle eminence in a fruitful plain, surrounded by hills, near the centre of the province; 65 miles E. Lisbon. The streets are narrow, crooked, and full of angles. It has no trade or manufactures; but contains five parish churches, twenty-three religious houses, and about twelve thousand inhabitants. The cathedral and other buildings are high and in the Gothic style. This city is said to have been founded by the Phœnicians, and walled round by Sertorius, who supplied the town with water by means of a beautiful aqueduct, (since entirely rebuilt by John III.,) and who, after having resided there for a considerable time, was buried, as tradition reports, in this place. Julius Cæsar constituted it a municipium, and named it *Liberaltas Julia*. It was taken by the Moors in the year 715, and retaken by the Christians under Giraldo, whose heroic conduct is celebrated by Camoens in his *Lusad*, in 1166, and then reduced under the dominion of Alphonso Henriques. In 1540 it was erected into

into an archiepiscopal see by pope Paul III.; and the first prelate founded an university, now fallen into decay. In this city are the remains of a temple of Diana, 7 pillars of which are standing, of the Corinthian order, connected by a plaster-wall. This edifice, at first a pagan place of worship, was converted into a Moorish mosque, and is now the butchers shambles. There are many other Roman vestiges, inscriptions, &c. particularly in the great square, which indicate the antiquity of this place. Its fortifications are 12 bastions, and two demi-bastions, and a castle in ruins. On the north side of Evora the hills rise, being round the town adorned with gardens, and on their summits with evergreen oaks. The road from hence to Montemor o novo, which lies at the distance of five leagues, passes over granite hills, partly covered with corn fields, and partly with fine woody or evergreen oaks and pastures. N. lat. 38° 30'. W. long. 7° 42'.

EVORAMONTE, a town of Portugal, in the province of Alentejo, seated on a rock, and containing about 800 inhabitants; 15 miles N.E. of Evora. N. lat. 38° 42'. W. long. 7° 31'.

EVORIA, a town of European Turkey in Livadia; 24 miles N. of Lepanto.

EUOSMA, in *Botany*, from *εὐοσμος*, *sweet-smelling*, because the flowers have the scent of hawthorn-blossoms. Jackson in Andr. Repof. t. 520. Class and Order, *Pentandria Monogynia*. Nat. Ord. *Rotacea*, Linn. *Gentiane*, Juss.

Gen. Ch. *Cal.* Perianth inferior, in five deep, obovate, concave, equal, permanent segments. *Cor.* of one petal, bell-shaped; tube dilated, as long as the calyx, pervious; limb in five broad, short, obtuse, spreading lobes. *Stam.* Filaments five, awl-shaped, shorter than the tube, inserted into its lower part, alternate with the lobes of the limb; anthers incumbent, roundish, compressed. *Pist.* Germen superior, oval, two lobed; style very short and thick; stigma capitate, four-lobed, on a level with the anthers. *Peric.* Capsule ovate, pointed, with a longitudinal furrow on each side, swelling irregularly from the projection of the seeds, of two valves, whole inflexed edges divide it into two cells; receptacles one in each cell, linear, triangular, parallel to the valves and close to the partitions. *Seeds* five or six in each cell, in two rows, oval, flattened on the inner side, all over rough with minute tubercles.

Ess. Ch. Calyx deeply five-cleft. Corolla bell-shaped, with a five-cleft border. Stigma four-lobed. Capsule superior, with two furrows and two cells, bursting at the top. *Seeds* several, oval, rough, affixed to a triangular receptacle.

1. *E. albiflora*. Andr. Repof. t. 520. Native of New South Wales, in the country near Port Jackson, from whence specimens and seeds were long ago sent by Dr. White. It is said to bear our winters in the open ground, flowering in April. *Stem* shrubby, with numerous, opposite, slender, square, leafy, slightly downy branches. *Leaves* opposite, on short stalks, lanceolate, acute, entire, smooth; shining and deep green above; paler, opaque, and somewhat glaucous beneath. *Stipulas* small, brittle-shaped, in pairs at the base of each footstalk, somewhat hairy. *Flowers* in dense, axillary, bracteated panicles, much shorter than the leaves; snow-white, small, but copious, and very fragrant. *Capsules* about a quarter of an inch long, obtuse, rugged, tipped with the short permanent style.

The characters above given will, we believe, distinguish this genus from *Exacum*, to which it is most allied of any in the same natural order. See *EXACUM*.

EVOVÆ, a barbarous word, says Rousseau, formed of

the six vowels, which begin the syllables of the words *seculorum amen*, and which is only used in canto sereno. It is from the letters of this word that the tone is found in the psalms and antiphonaria of the Roman catholic church, and the notes by which the verses of the psalms and canticles must be terminated.

The evovæ always begins by the dominant of the mode and ends upon the final.

EVOUTS, in *Geography*, a small island in the Southern Pacific ocean; 15 miles S. from Terra del Fuego. S. lat. 55° 33'. W. long. 67° 36'.

EUPAREIA, in *Botany*, *εὐπαρεία*, having beautiful checks, in allusion probably to the scarlet colour of the flowers, said to resemble *Anagallis arvensis*. Gærtn. v. 1. 230. t. 50. Schreb. 156. Willd. Sp. Pl. v. 1. 1183. Mart. Mill. Dict. v. 2. Class and order, *Pentandria Monogynia*. Nat. Ord. *Lyfsmachia*, Juss.

Gen. Ch. *Cal.* Perianth inferior, of five lanceolate, acute leaves. *Cor.* Petals from five to twelve, lanceolate, spreading, longer than the calyx. *Stam.* Filaments five; anthers. *Pist.* Germen roundish, superior; style bristle-shaped, long; stigma simple. *Peric.* Berry dry, globose, crowned with the permanent style, of one cell. *Seeds* numerous, roundish, small, affixed to a globose, fungous, central receptacle.

Ess. Ch. Calyx of five leaves. Petals from five to twelve. Berry superior, dry, of one cell, with many seeds. Receptacle globose.

*E. amana* is the only known species, gathered in New Holland by sir Joseph Banks and Dr. Solander. Gærtner describes it as a procumbent plant, resembling *Lyfsmachia nummularia*, but about one-fourth its size. Flowers of the colour of the Scarlet Pimpernel. He adds that "the seed-vessel, which ever way pressed, would not open by regular valves, so that it is very nearly allied to *Trientalis*." Indeed his figures betray the very close affinity, even the identity of these two genera, except that one is described as polypetalous, the other monopetalous, and that the stamens of *Eupareia* are not said to equal the petals in number, when the latter are more than five.

EUPATORIA, formerly KOSLOF, or *Goslove*, in *Geography*, a town and district of Russia, in the province of Taurida or Crim Tartary, near the Black sea. N. lat. 45° 40'. E. long. 33° 14'.

EUPATORIA, or *Pompeiopolis*, in *Ancient Geography*, *Akneschid*, a town in the N.W. part of the Tauris Chersonesus.

EUPATORIA, *Amid*, a town of the kingdom of Pontus, situated in the gulf of Amisa, and contiguous to a town of the same name. Mithridates Eupator is said to have built it, and to have given it his name.

EUPATORIUM, in *Botany*, *εὐπατόριον* of Dioscorides, from Mithridates, surnamed Eupator, who is reported to have brought this plant into use as a counter-poison. Linn. Gen. 413. Schreb. 546. Willd. Sp. Pl. v. 3. 1748. Sm. Fl. Brit. 859. Mart. Mill. Dict. v. 2. Juss. 178. Gærtn. t. 166. Class and order, *Syngenesia Polygamia-aqualis*. Nat. Ord. *Compositae discoidæ*, Linn. *Corymbifera*, Juss.

Gen. Ch. *Common Calyx* oblong, imbricated; scales linear-lanceolate, erect, unequal, unarmed. *Cor.* compound, uniform, discoid; florets all uniform, perfect, fertile, monopetalous, funnel-shaped, with a regular, five cleft, spreading border. *Stam.* Filaments five, capillary, very short; anthers united into a cylindrical tube. *Pist.* Germen minute; style thread-shaped, very long, cloven down as far as the top of the anthers, straight; stigmas slender, bluntish; straight.

straight. *Peric.* none, except the permanent calyx. *Seeds* solitary, oblong, angular; down long, rough, or feathery. *Recept.* naked.

*Eff. Ch.* Receptacle naked. Down rough or feathery. Calyx imbricated, oblong. Style prominent, cloven half way down, divaricated.

A large genus, chiefly, though not entirely, American. The *roots* are perennial. *Stem* sometimes shrubby. *Leaves* opposite, mostly simple, and strongly serrated. *Flowers* corymbose, terminal, numerous, white, bluish, or reddish. Whole plant, roughish, bitter, or aromatic. Willdenow has 71 species.

*E. cannabinum*, Engl. Bot. t. 428, singular for having fingered leaves, which indeed are sometimes found undivided, is the only British species. It grows in watery places about the banks of rivers, or in mountainous boggy thickets, where it with us supplies the place of the Swiss *Cacalia alpina*, which its pink flowers somewhat resemble.

Several of the American species are esteemed in that country, on account of their aromatic and tonic qualities, and known by the name of Fever root, or Fever weed. Among these, we believe, are *E. sessilifolium*, *perfoliatum*, and *aromaticum*, but we want further information on this subject.

*E. Aya-pana*, Venten. Jard. de la Malmaison, t. 3. a native of the banks of the river of the Amazons, is said to be "an excellent sudorific and alexipharmic;" partaking therefore, no doubt, of the virtues of the above-mentioned species. Its *leaves* are lanceolate, nearly entire, and not accurately opposite. The *flowers* are purplish.

*E. zeylanicum*, Linn. Sp. Pl. 1172, has decidedly alternate leaves, so as to have raised a doubt in the mind of Linnæus whether it could belong to this genus; yet its fructification seems altogether like the generality of the species.

EUPEGIUM, in *Ancient Geography*, a town of Greece, in the Peloponnesus.

EUPEN, or OEPEN, in *Geography*, a town of France, in the department of the Ourthe, and chief place of a canton in the district of Malmédy; 4 miles E.N.E. of Limburg. The place contains 6,749, and the canton 12,616 inhabitants, on a territorial extent of 102½ kilometres and seven communes. Here is a considerable manufacture of cloth.

EUPETALOS, in *Natural History*, the name of a gem described by the ancients as famous for its variety of colours. Pliny, lib. xxxii. cap. 10. tells us, that it shewed at once blue, fire-colour, red-lead colour, and yellow. It seems to have been the opal, and that Pliny's description of it in this place was taken from some author he did not perfectly understand, as is the case in many of his accounts from the Greeks.

EUPHASEE, in *Geography*, the ancient name of Hiwassee river in Tennessee, N. America; also the name of an Indian town on its S.W. bank, 28 miles from its mouth. See HIWASSEE.

EUPHEMISMUS, Εὐφημισμός, of *eu*, well, and *φνις*, I speak, in *Rhetoric*, a figure which expresses things in themselves disagreeable and shocking, by terms implying the contrary quality; that is, the Pontus, or Black sea, having the epithet of ἀξυός, (i. e. inhospitable) given it on account of the savage cruelty of those who inhabited the neighbouring countries; this name, by euphemism, was changed into that of Euxinus. Thus Ovid. Trist. lib. iii. eleg. 13.

"Dum me terrarum pars pene novissima Ponti

Euxinus falso nomine dictus habet."

In which sense it only makes a species of irony. But every euphemism is not irony; for we sometimes use improper

and soft terms in the same sense with the proper and harsh. See Voss. Rhet. lib. iv. cap. 186, seq.

EUPHEMIUS, in *Biography*, succeeded to the high dignity of patriarch of Constantinople in the year 490. He was zealously attached to the doctrines of the Catholic church, of which he gave proof by striking out from the lists of persons in communion with the church, the name of Peter Mongus, patriarch of Alexandria, because that prelate had pronounced an anathema against the council of Chalcedon. This circumstance produced a violent schism between the two patriarchs, who convened their respective synods, in which they mutually procured excommunications of each other to be issued. In the year 491, on the death of Zeno, when Anastasius was taking measures to secure the imperial throne, Euphemius warmly opposed him, on account of his known Arian principles, and when he found his opposition fruitless, he refused to crown the new emperor till he had delivered to him a written confession of orthodox faith, and engaged under his hand, and by the sanctity of an oath, to maintain the principles of the Catholic doctrine, as established by the council of Chalcedon. In the year 493, Theodoric, having become master of Italy, sent ambassadors to Anastasius to treat for peace, to which Euphemius was thought to be the chief obstacle. In a short time afterwards Anastasius having confidentially informed the patriarch of his desire to terminate in an honourable manner the war in which he was engaged with the Isaurians, Euphemius betrayed his secret to the patrician John, the father-in-law of Athenodorus, one of the chiefs of the Isaurians. The emperor was made acquainted with the patriarch's conduct, and laid the case before an assembly of bishops, who were convened at Constantinople in the year 495, and by his influence with them, obtained a decree that Euphemius should be deposed, and cut off from the communion of the church. He afterwards obtained a sentence of banishment against Euphemius, who died at Ancyra in the year 515. Moreri.

EUPHON, in *Acoustics*, a musical instrument lately contrived by Dr. Chladni of Wittenberg, who, in consequence of a variety of experiments on the longitudinal vibrations of elastic bodies, constructed this instrument, so called from its pleasant sound, which consists of glass tubes disposed in a proper frame, and expressing their sounds by being rubbed longitudinally. The euphon has some resemblance to a small writing desk. When opened, the glass tubes, of the thickness of the barrel of a quill, and about 16 inches long, are seen in an horizontal position. They are wetted with water by a sponge, and stroked with the wet fingers in the direction of their length, so that the increase of the tone depends merely on the stronger or weaker pressure, and the slower or quicker movement of the fingers. The number of tubes is 42. In the back part there is a perpendicular sounding-board divided in the middle, through which the tubes pass. From this construction it appears, that the euphon should not be considered as an altered or improved harmonica, (See ARMONICA), but as a totally new and different instrument. In regard to sweetness of sound, it approaches very near to the harmonica; but it possesses several advantages, peculiar to itself. It is simpler, with regard both to its construction and the movement necessary for producing the sound, as neither tuning nor stamping is required, but merely the movement of the finger. It produces its sound more speedily; so that as soon as it is touched you may have the tone as full as the instrument is capable of rendering it; whereas in the harmonica, the tones, particularly the lower ones, must be made to increase gradually.

It has also greater distinctness in quick passages, because the tones do not rebound so long as in the harmonica, where the sound of one low tone is often heard when you wish only to hear the following tone. The unison is purer than is generally the case in the harmonica, where it is difficult to have perfect glasses, which in every part give like tones with mathematical exactness. It is however as difficult to be tuned as the harmonica. It does not affect the nerves of the performer; for a person scarcely feels a weak agitation in the fingers; whereas in the harmonica, particularly in concords of the lower notes, the agitation extends to the arms and even through the whole body of the performer. This instrument is less expensive than the harmonica; when one of the tubes breaks, or any other part is deranged, it can soon be repaired, and at very little expence: whereas, when one of the glasses of the harmonica breaks, it requires much time and is very difficult to procure another capable of giving the same tone as the former, and which will correspond sufficiently with the series of the rest. For an account of the experiments that led the author to the construction of this instrument, and of the various stages of his progress in the improvement of it, we refer to the *Philosophical Magazine*, vol. ii. p. 391, &c.

**EUPHONIC ACCENT.** See ACCENT.

**EUPHONY**, in *Elocution and Composition*, that sweet or pleasing quality in the successive sounds of language, which results from happy combinations of the enunciative elements, such especially as, though essentially different in their characteristic powers, melt easily into each other so as to preserve an uninterrupted flow of utterance through the respective members of a sentence, without labour to the speaker, or offence to the hearer. The word is formed of *e*, *bene*, *well*, and *φων*, *vox*, *voice*. Quintilian calls *euphonia*, *vocalitas*; Scaliger, *facilis pronuntiatio*. The most obvious rule with respect to euphonic composition is that a due mixture should be made of consonants and vowels; and the principle of this rule may be at once explained and illustrated by the following parody on a famous but sophistical couplet in Pope's *Essay on Criticism*,

“Your consonants with vowels well combine,  
And twelve small words may flow in one smooth line.”

But this is not all that is requisite for perfect euphony: every vowel does not blend with equal grace and facility with every consonant; nor is every succession of mere vowels, or every succession of consonants, equally offensive or cacophonous. Words or syllables, for example, terminating with thin vowels, may be followed by other words or syllables, commencing with broad or open vowels, or the reverse, with very happy effect; and some consonants may be brought together, in immediate succession, even as terminative and initial elements of following syllables or words, in such way as rather (while they increase the sonorous energy of such composition,) to diversify the time and expression, than to disturb the euphony of the sentence. All the liquids especially (those that properly ought to be, as well as those that commonly are so called) combine with almost equal facility with other liquids, and with vowels or with the consonants, whether semi-liquids, sibilants, or mutes. (See LIQUID, MUTE, &c.). Which of these, and under what circumstances, may be thus brought together, with the happiest effect of euphony and expression, it would require a much longer discussion than we have space for, to ascertain; and, after all, much must be left to the taste, the ear, and the experimental discrimination of the writer. But it is not upon the writer alone, that the effect of euphony depends. The reader or reciter must also do

his part, for though it is very possible so to write, that no organs, and no management of those organs, can elicit in the delivery, any thing but the dissonance of cacophony; there are some pedants who contrive to render even the smoothest compositions harsh and cacophonous, and then ascribe to their native language, (of the very elements and genius of whose oral composition they are utterly ignorant,) the disgusting dissonance which does, in reality, belong to their own jargonized utterance. Euphony in the reader or speaker depends principally upon his skill and management in the articulation and implication of the successive elements, syllables, and words as explained under the term ENUNCIATION; and upon his giving full tune, and sufficient quantity to the liquids and liquifiable consonants. Cacophony (the antagonist of Euphony) on the contrary, results in the reader, from the laboured separation of terminatives and initials, that might easily have been implicated; from giving unnecessary impulse and force to the mutes, from hurrying over the liquids, and partially tuneable elements, as if they were mere mutes, and from perpetual unnecessary interruptions in the stream of enunciative delivery.

**EUPHORBIA**, in *Botany*, *εὐφορβιον* of Dioscorides, so named after Euphorbus, physician to Juba king of Lybia. Spurge. Linn. Gen. 243. Schreb. 326. Willd. Sp. Pl. v. 2. 881. Sm. Fl. Brit. 513. Mart. Mill. Dict. v. 2. Juss. 385. Class and order, *Dodecandria Trigynia*. Nat. Ord: *Tricocca*, Linn. *Euphorbia*, Juss.

Gen. Ch. *Cal.* Perianth interior, of one leaf, inflated, somewhat coloured, with four, in some few instances five, marginal teeth, permanent. *Cor.* Petals, or Nectaries, four, sometimes five, turbinate, gibbous, thick, abrupt, unequal in situation, alternate with the teeth of the calyx, inserted into its margin by their claws, permanent, bearing plenty of honey. *Stam.* Filaments numerous, 12 or more, thread-shaped, jointed, longer than the corolla, inserted into the receptacle, coming to maturity at different periods, separated by bristly scales; anthers roundish, of two distinct lobes. *Pist.* Germen superior, roundish, three-sided, elevated on a stalk above the margin of the calyx; styles three, cloven; stigmas obtuse. *Peric.* Capsule stalked, roundish, three-lobed, of three cells, and three valves which separate elastically. *Seeds* solitary, roundish.

Obsl. The petals or nectaries are for the most part four, in some flowers five, which often happens on the same plant, such flowers being furnished with stamens only, without a pistil, and coming forth earlier than the rest. In many the petals are glandular, in others crescent-shaped, or toothed; in some few thin and membranous; they are commonly situated as it were on the outside of the calyx. The capsule is either smooth, or hairy, or warty.

Ess. Ch. Calyx of one leaf, inflated, inferior. Nectaries four or five, inserted into the calyx. Capsule stalked, three-lobed.

A vast, but very natural, genus, whose species amount in Willdenow's work to 124. They are divided into several sections. All abound with an acrid milk.

Those of the first section have a very peculiar thick, shrubby, fleshy, angular stem, armed with spines, and bearing few or no leaves. To this belongs *E. officinarum*, probably the original species. See its figure in Commelin's Hort. Amit. v. 1. t. 11. Also *E. antiquorum*, ib. t. 12, an East Indian plant, which seems very improperly named, as neither agreeing with the descriptions of the ancients, nor growing in the country whence they procured their *εὐφορβιον*.

The second section has shrubby stems without thorns, neither forked nor umbelliferous. As *E. Caput Medusæ*, Comm.

Comm. Hort. t. 17, common in Green-houses; and *E. petiolaris*, Curt. Mag. t. 883.

The third has forked stems, not umbelliferous, and the plants are mostly herbaceous and annual, as *E. pida*, Jacq. Ic. Rar. t. 477, and *pidulifera*, t. 478; also *E. Peplus*, Engl. Bot. t. 2002, common on the sea shores of the south of Europe.

The fourth has the flowers in an umbel, three-branched in the first instance, and the branches subsequently forked repeatedly, each subdivision of the inflorescence accompanied by a pair of heart-shaped, unequal sided, somewhat coloured bractæus, as our common weed *E. Peplus*, Curt. Lond. fasc. 1. t. 35. Engl. Bot. t. 959.

The fifth has a four-branched umbel, as the great *E. Lathyris* of the gardens, commonly called the Caper tree, remarkable for its long, dark, four-rowed leaves. There are but few species in this section.

The sixth, a numerous section, has a five-branched umbel, like the common *E. helioscopia*, Curt. Lond. fasc. 1. t. 36. Engl. Bot. t. 883; and the rare and splendid *E. punicea*, Sm. Ic. Pict. t. 3, a shrubby Jamaica plant, of which a most miserable specimen is drawn in Jacq. Ic. Rar. t. 484.

The seventh and last section consists of such species as have numerous rays to the common umbel, like *E. Cyparissias*, Engl. Bot. t. 840, frequent in gardens, and *amygdaloides*, t. 256, very common in woods.

EUPHORBIA, in *Gardening*, comprehends plants of the herbaceous, shrubby, succulent kinds, the principal cultivated species of which are; the triangular spurge (*E. antiquorum*); the Canary spurge (*E. canariensis*); the official spurge (*E. officinarum*); the Medusa's head spurge (*E. caput Medusæ*); the myrtle-leaved spurge (*E. tithymaloides*); the seven-angled spurge (*E. heptagona*); the warty-angled spurge (*E. mammilaris*); and the Cape spurge (*E. lathyris*): the first species is a large plant, of which there is a variety with a naked three-cornered compressed stalk, sending out a great number of erect branches, which are likewise generally three-cornered, but sometimes four-cornered; armed with short crooked spines, having no leaves. The plants have not, we believe, yet produced flowers in this climate. This variety, like the species from which it is produced, is a native of the East Indies.

The fourth species has also a variety frequently denominated the "Little Medusa's head," which has a thick short stalk, seldom more than eight or ten inches in height, from which come out a great number of slender trailing branches, about a foot in length, intermixing, and having the same appearance with the other, but smaller and much shorter; the ends are beset with narrow leaves, between which the white flowers come out and appear. Its native situation is the same as that of the species from which it is derived. According to some there are likewise a double branching, a dwarf trailing, and other varieties.

The fifth sort has also laurel leaved and variegated leaved varieties.

*Method of Culture.*—These different sorts of plants may be raised by planting cuttings, which have been made at a joint, five or six inches in length, after having been rolled in sand, and laid upon a shelf for some days to have the wounds healed over, in the summer season about the middle, choosing small pots for the purpose filled with light, dry, sandy mould, with some rubbish at the bottoms, such as that formed of one fourth part of lime-rubbish which has been well screened, the same quantity of sea sand, and one half of the whole of light fresh vegetable earth, which should be very well mixed and incorporated together, by

being often turned over; then plunging the pots in the back hot bed, giving due shade when the weather is hot and sunny, with a little water occasionally once or twice a week. As soon as the plants have stricken root, air should be admitted to them pretty freely in the situation in which they may be; or they may, in order to be hardened, be removed into the stove.

In the after management they should be allowed larger pots annually as they advance in growth, and be often refreshed with water during the summer months, but very sparingly in the winter season.

It may be remarked that most of these sorts of plants are capable of being kept in the hot-house, on the shelves, and some of them, as the fifth, sixth, and seventh sorts, in a dry airy green-house, or glass case, during the winter months, great care being taken to protect them well from the frosts; being set out in the summer in the open air: but the fourth species requires some sort of support in order to prevent the branches, by their weight, forcing it upon the pots; as by this sort of treatment the plants will rise to the height of four or five feet, throwing out a great number of side branches. The eighth kind, however, requires little or no particular care after it has been once introduced, except merely that of keeping the young plants clean, as it will be continued by its scattering the seeds.

All these plants, with the exception of the last, afford great variety in collections of the hot and green-house kinds; and that also in the clumps and borders of the pleasure grounds, among others of the less hardy sorts.

EUPHORBIAE, in *Botany*, the 96th natural order in Jussieu's system, or the 1st of his 15th class. The definition of this class is,—Coryledons two. Petals none. Stamens in a separate flower from the pistils. Its characters are thus more fully explained. Flowers either monoecious, that is, males and females together on the same plant, or dioecious, on separate ones; very rarely hermaphrodite. Calyx in all of one leaf, or a scale supplying its place. Corolla none, except occasionally some scales, or internal divisions of the calyx, resembling petals. In the male flowers the stamens are inserted either into the upper or lower part of the calyx, or scale which supplies its place, definite, or rarely indefinite, in number; their filaments distinct, or rarely united into a central stalk, originating from the middle of the calyx. Germen in the females simple, or sometimes more than one, superior, or rarely inferior; style one, or several, rarely wanting; stigma either solitary or more than one. Fruit either superior or inferior, various in the structure and number of its cells.

The learned author, by his subsequent remarks and explanations, is evidently aware of the difficulties attending this class, which indeed is in no sense really a natural one, its orders having little or no affinity to each other, except the two last *Amentacea* and *Conifera*.

The characters of the order of *Euphorbiae* are, *Flowers* monoecious or dioecious, or rarely hermaphrodite. *Calyx* of each tubular, or deeply divided, simple or double, the internal segments occasionally resembling petals. *Petals* none, except the segments just mentioned. *Stamens*, in the male flowers, definite or indefinite in number, their filaments inserted either into the receptacle, or the centre of the calyx, distinct or united, sometimes branched, sometimes jointed. In some there are chaffy scales between the filaments. *Germen*, in the female flowers, solitary, superior, sessile or stalked; styles in some cases several, often three, with an equal number of cells to the capsule, each containing one or two seeds; in others the style is simple, with three or more stigmas, the fruit of le-

veral cells, equalling the stigmas in number, with one or two seeds in each. In all the cells are furnished with two internally elastic valves; the seeds have a partial covering, and are attached at the upper part to the permanent central axis of the fruit. Coraculum flat, enveloped in a fleshy albumen. The plants are either herbaceous, or shrubby, or arborecent; some of them milky. Leaves alternate or opposite, (in some few instances wanting,) either with or without stipulas. The first section consists of such genera as have several styles, mostly three. These are *Mercurialis*, *Euphorbia*, *Argythamnia* of Brown's Jam. 338. Sw. Prod. 39, *Cicca*, *Phyllanthus*, *Xylophylla*, *Kirganelia*, *Kiggellaria*, *Clusia*, *Andrachne*, *Agyneia*, *Buxus*, *Securinega* of Commerfon, *Adelia*, *Mabea*, Schreb. 641, *Ricinus*, *Jatropha*, *Dryandra*, *Aleurites*, *Croton*, *Acalypha*, *Caturus* and *Excaccaria*. The second section, with a solitary style, contains *Tragia*, *Stillingia*, *Sapium* of Brown, *Hippomane*, *Egopricon*, *Secchium* of Brown, *Hura*, *Omphalea*, *Plukenetia* and *Dalechampia*.

The seeds of these plants are mild and eatable in many instances, if freed from their integuments and coraculum, the latter being very dangerously purgative, as in *Euphorbia* and even *Ricinus*, proving mild in the latter only from the copious oil of the cotyledons. *Euphorbia*, which gives its name to this natural order, can only by a very bold analogy, or rather hypothesis, be said to have no corolla, and is very imperfectly polygamous, not monoecious; indeed Jussieu allows it to be hermaphrodite. See EUPHORBIA.

EUPHORBIVM, is a most acrid gum resin, which exudes from the *Euphorbia officinarum* and other shrubs of the same genus, and was formerly used in pharmacy, but is now nearly, if not, entirely rejected.

This gum is brought from Barbary and other parts of the Mediterranean in tears or drops of an irregular form, generally entangling much impurity; of a pale yellow colour without, and white within. Euphorbium has no smell: when taken into the mouth it gives at first no taste, but after a little time a most acrid biting sensation is felt, which increases to an intolerable degree, and if not immediately rejected it proceeds to corrode the skin of the tongue and fauces. The same acrimony is shewn when applied to the body in any other manner. In reducing it to powder the dust that flies off will excite the most violent sneezing, and often bleeding from the nostrils and throat, so that particular precautions must be taken. When laid for some time on the skin it blisters.

The spirituous tincture of euphorbium is still more acrid.

This gum resin, on account of its extreme acrimony, can hardly be used with safety as an internal medicine, as it is liable to produce violent diarrhoea and bloody stools, and much inflammation. The only purpose for which it has been employed in the later dispensaries has been in mixture with cantharides to increase the vesicating and irritating property, but euphorbium is now altogether disused.

EUPHORIA, in *Botany*, so named by Commerfon from *εὐφορος*, fertile, a genus comprehending the two Chinese fruits Lit-chi and Longan, to which Jussieu suspects Forster's *Pometia* may also belong. See SCYTALIA.

EUPHORY, signifies the same as *Eucrazy*.

EUPHRASIA, in *Botany*, from *εὐφρασα*, to exhilarate, or delight, alluding to the brightness or gaiety of the blossoms. Eye-bright. Linn. Gen. 304. Schreb. 401. Willd. Sp. Pl. v. 3. 192. Tournef. t. 78. Sm. Fl. Brit. 650. Mart. Mill. Dict. v. 2. Juss. 100. Gært. t. 54. Class and order, *Didynamia Angiospermia*. Nat. Ord. *Personate*, Linn. *Pediculares*, Juss.

Gen. Ch. Cal. perianth of one leaf, inferior, cylindrical,

four-cleft, equal, permanent. Cor. of one petal, ringent; tube as long as the calyx; upper lip concave, notched; lower spreading, deeply three-lobed, its lobes equal, obtuse, notched. Stam. Filaments four, thread-shaped, situated close under the upper lip; anthers of two lobes, the lobes unequally spinous at their lower extremities. Pist. Germen superior, ovate; style thread-shaped, agreeing in form and situation with the stamens; stigma obtuse, undivided. Peric. Capsule ovate-oblong, compressed, of two cells and two valves; the partition contrary to the valves. Seeds numerous, minute, roundish, longitudinally striated.

Ess. Ch. Calyx cylindrical, four-toothed, equal. Upper lip of the corolla cleft; lower three-lobed, the lobes cleft. Anthers bearded with unequal spines. Capsule ovate-oblong. Seeds striated.

Botanists are not perfectly agreed about the limits of this genus, and its near allies *Bartsia* and *Rhinanthus*. The first of Willdenow's twelve species, *E. latifolia*, Linn Sp. Pl. 841, is *Bartsia latifolia*, Sm. Prod. Fl. Græc. Sib. 428, a beautiful native of the south of Europe. His sixth, *E. odontites*, is *Bartsia odontites* of Hudf. Fl. Angl. 268, and Sm. Fl. Brit. 648. Engl. Bot. t. 1415.

*E. officinalis*, Linn. Sp. Pl. 841. Engl. Bot. t. 1416. Curt. Lond. fasc. 5. t. 42. common in heathy and mountainous pastures, which its gay blossoms greatly enliven in autumn, is a genuine and original example of the genus. This is a small, upright, annual plant, with ovate sharply serrated leaves. The flowers are white, strongly streaked with purple, having a yellow spot on the lip. On the Alps they are often larger, light purple, and still more beautiful.

The dazzling brilliancy of these little blossoms seems to have given rise to the vulgar opinion, that the plant was good for the eyes; whence its English name Eye-bright.

EUPHRATENSIA, in *Ancient Geography*. See COM-MAGENE.

EUPHRATES of Alexandria, in *Biography*, a Stoic philosopher, who flourished in the second century; was a friend of Dio and of Apollonius Tyanæus, who introduced him to Vespasian. Although a violent quarrel arose between the latter philosopher and Euphrates, in consequence of which Philostratus, the panegyrist of the former, inveighs with great severity against the latter, it appears from the testimony of Epictetus, Pliny the younger, and Eusebius, that Euphrates was universally esteemed for his talents and virtues, and that the censures of Philostratus deserve only contempt. Pliny's character of him is highly interesting. "If ever," says he (Ep. l. i. ep. 10.), "polite learning flourished at Rome, it certainly does at present. Of this I could give you many instances; but I will content myself with naming only Euphrates the philosopher. When, in my youth, I served in the army in Syria, I had an opportunity of conversing familiarly with this excellent man, and took some pains to gain his affection, though that indeed was not difficult; for he is exceedingly open to access, and full of that gentleness of manner which he teaches. Euphrates is possessed of shining talents, which cannot fail to interest even the unlearned. He discourses with great accuracy, dignity, and elegance; and frequently rises into the sublimity and luxuriance of Plato himself. His style is copious and diversified, and so wonderfully sweet, as to captivate even the most reluctant auditor. Add to all this, his graceful form, comely aspect, long hair, and large white beard; circumstances which, though they may probably be thought trifling and accidental, contribute, however, to procure him much reverence. There is no disgusting negligence in his dress; his countenance is grave, but not austere; his approach commands respect, without exciting awe.

With the strictest sanctity, he unites the most perfect politeness of manner. He inveighs against vice, not against men; and, without chastising, reclaims the offender. You listen with fixed attention to his exhortations, and even when convinced, still hang with eagerness upon his lips."

In conformity to the principles of the Stoic philosophy, Euphrates, when he found his strength worn out by disease and old age, voluntarily put a period to his life by drinking hemlock, having first, for some unknown reason, obtained permission from the emperor Adrian. Brucker's *Hist. Phil.* by Enfield, vol. ii.

EUPHRATES, the reputed founder of a religious sect in the second century, sometimes called "Ophians," or "Ophites," and sometimes "Serpentinians," names derived from the peculiar tenet which he held, that the serpent, by which our first parent was deceived, was either Christ himself, or "Wisdom" concealed under the form of that animal, and that he was the occasion of all the knowledge which men had received. Hence he is said to have inculcated a particular veneration for the serpent, preserving a living one, offering to it a subordinate kind of divine honour, and bringing it out to partake of or to consecrate the eucharist. Origen and others contend that the followers of Euphrates were not Christians, but calumniators of Jesus Christ, and opposers of his doctrine: but Dr. Lardner, who has taken some pains in investigating the subject, considers them as believers in Christianity, and maintaining that Jesus, who was born of a virgin, was a most excellent man, and that, having by his miracles and instructions manifested himself to be the true Messiah, was crucified, and afterwards raised from the dead, received into heaven, where he sits on the right hand of God. He conceives that what some have said of them, respecting the serpent being Christ, must be a mistake, founded on an opinion that the brazen serpent in the wilderness was a type or figure of Christ. The other accounts of worshipping the serpent, &c. this judicious and learned writer rejects without hesitation. Moreri. Lardner.

EUPHRATES, in *Ancient Geography*, one of the most considerable and best known rivers of Asia, the source of which was in the mountains of Armenia north of Abus, which after receiving several streams in this part of Armenia, at the towns of Elegia, Gymnias, and Brapus, pursued its course towards the south-west, separating Armenia Major, on the east, from Armenia Minor on the west. It then proceeded south-eastward, washing the skirts of Syria, and dividing Arabia from Mesopotamia; and afterwards directing its course towards the north-east, it separated Chaldæa and Babylonia from Mesopotamia, till at length mixing its waters with those of the Tigris, with which it previously communicated by several canals, it emptied itself into the Persian gulf. The Euphrates, according to Ptolemy, above Babylon, near a town in Mesopotamia, called Siphara, divided itself into two branches, one running to Babylon, and the other to Seleucia, where it fell into the Tigris. Pliny says the latter was partly artificial; for he places Seleucia at the confluence of the Tigris and Euphrates, adding that the Euphrates was conveyed to it by a canal. Prideaux, on the authority of Pliny, ranks this artificial branch among the stupendous works of Nebuchadnezzar. Between these two branches a canal was cut from the Euphrates, above Babylon, to the Tigris at Apamea, 60 miles below Seleucia. This canal was denominated *Naarmalecha*, and was dug by Nebuchadnezzar, as Abydenus informs us, to convey the waters of the Euphrates, when it overflowed, into the Tigris, before they reached Babylon. At the distance of 800 furlongs from Babylon to the south was another canal, called by Arrian Pallacopes, and by Appian Pallacotta,

derived from the branch of the Euphrates that passed through Babylon, and continued to certain lakes or marshes in Chaldæa. On this canal, or river, as Arrian calls it, Alexander sailed from the Euphrates to the above-mentioned lakes. But it is impossible, at this distance of time, and after the changes that have occurred, to trace out the numerous branches and canals which watered the ancient country of Babylon. This great river moved slowly through a great part of its course, and was ill adapted for navigation, as some parts of it were shoal and others rocky. Thevenot, however, is of opinion, that the Euphrates might, with little trouble, be made navigable, even by great barks, quite to the Tigris, only by clearing the channel of the stones with which it is choked in some places. The ancient mode of navigating this river was very extraordinary. The vessels were round, without distinction of head or stern, and no better than great wicker baskets, covered over with hides, guided by two oars or paddles. They were capable of carrying a very considerable weight; and when they had unloaded their cargo at Babylon, they were sold, but the hides were kept: and loading their asses with them, the navigators returned home by land, the rapidity of the stream not allowing them to return by water.

EUPHRATES, in *Modern Geography*, a river of Asiatic Turkey, which rises from the mountains of Armenia, as some have said, in two streams, a few miles to the N.E. of Erzeron, the streams uniting to the S.W. near that city; and chiefly pursuing a S.W. direction to Semisat, where it would fall into the Mediterranean, if not prevented by a high range of mountains. In this part of its course the Euphrates is joined by the Morad, a stream almost doubling in length that of Euphrates, so that the latter river might more justly be said to spring from mount Ararat, about 160 British miles to the east of the imputed source. At Semisat, the ancient Samofata, this noble river assumes a southerly direction; then runs an extensive course to the S.E., and after receiving the Tigris, falls by two or three mouths into the gulf of Persia, about 50 miles S.E. of Basfora. N. lat. 29° 50'. E. long. 66° 55'. The comparative course of the Euphrates may be estimated at about 1400 British miles. This river is navigable for a considerable distance from the sea. This river in its course separates Aladulia from Armenia, Syria from Diarbekir, and Diarbekir from Arabia, and passing through the Arabian Irak, there joins the Tigris.

EUPHRATES, a river of Africa, in the country of Whidah, on the Slave coast.

EUPHROSYNE, in *Mythology*, one of the three Graces. See GRACES.

EUPHROSYNUM, in *Botany*, a name used by Pliny and some others for the common borragé. See BORRAGE.

EUPILIS, in *Ancient Geography*, *Puffiano*, a lake of Italy, in Gallia Cisalpina, whence, according to Pliny, issued the river Lambrus.

EUPNCEA, of *eu*, *well*, and *πνεω*, *I breathe*, in *Medicine*, is a right and natural respiration.

EUPOLIS, in *Biography*, an Athenian who flourished B.C. 440, was known as a comic writer, and one of that class who marked out by name the objects of their satire, which rendered him extremely popular with the many, as he was dreaded by the great. He is mentioned by Horace and Quintilian, who put him in the same class with Cratinus and Aristophanes. His comedies were of a political cast, in one of which Alcibiades was so severely attacked, that he is said to have hired assassins to throw him into the sea. The plot did not succeed, for Eupolis wrote several comedies after the period assigned to this fact, and Ælian relates that

that he died at Ægina. Fragments of his works have come down to us, and titles of twenty of his plays. Gen. Biogr.

**EUPORIA**, in *Ancient Geography*, a town of Macedonia, placed by Ptolemy in Bifaltia.

**EUPORIA**, of *eu* and *πορος*, *passage*, in *Medicine*, is an easy preparation of medicines, or the easiness of their operation.

**EUPSYCHIANS**. See **EUNOMIOEUPSYCHIANS**.

**EURA**, in *Geography*, a town of Sweden, in the government of Abo; 17 miles N.E. of Abo.

**EVRA**, a town of Abyssinia; 12 miles S.E. of Siré.

**EVRA**, a town of Sweden, in the government of Abo; 17 miles S. of Biorneborg.

**EVREN**, a town of France, in the department of the North Coasts, and chief place of a canton in the district of Dinan, four miles S. of it. The place contains 3573, and the canton 9175 inhabitants, on a territorial extent of 117½ kilometres and seven communes.

**EURAN ISLANDS**, a cluster of small islands, on the east side of the gulf of Bothnia. N. lat. 63° 54'. E. long. 22° 39'.

**EURANIUM**, in *Ancient Geography*, a town of Asia Minor, in Caria.

**EURE**, in *Geography*, a river of France, which has its source in the forest of Logny, and terminates in the Seine, above Pont de l'Arche. Its course is northward, and extends 36 leagues.

**EURE**, formerly *Ouche*, a department of the second or northern region of France, in 49° N. latitude, bounded on the north by the department of the Lower Seine, on the east by that of the Oise, on the south by the departments of the Eure and Loire and the Orne, and on the west by the department of the Calvados. It takes its name from the river Eure, which traverses it; and its capital is Evreux. It contains 307 square leagues, and 415,574 inhabitants in five districts, *viz.* Pontaudemer, Louviers, Les Andelys, Evreux, and Bernay, 35 cantons, and 843 communes. Its fertile soil yields grain, hemp, flax, and pastures; and it has considerable forests.

**EURE and Loire**, a department of the second or northern region of France, in 48° 15' N. lat. composed of a part of *Beauce* and of *Perche*, bounded on the N.W. by the department of the Eure, on the east by the departments of the Seine and Oise and the Loiret, on the south by the departments of the Cher and Loiret, and on the west by the departments of the Orne and Sarthe. It takes its name from the rivers Loire and Eure, which water it; and its capital is Chartres. It contains 300 square leagues, and 259,967 inhabitants. It is divided into four districts, *viz.* Nogent-le-Rotrou, Chartres, Chateaudun, and Dreux; 23 cantons, and 460 communes. This department, on account of its great fertility, is called the granary of Paris, and it abounds in fruits and rich pastures.

**EVRE**, or **YEVRE**, a river of France, which discharges itself into the Cher by two streams, one near Vierfon, the other at Bourges.

**EVRECY**, a town of France, in the department of the Calvados, and chief place of a canton in the district of Caen; seven miles S.W. of Caen. The place contains 850, and the canton 13,110 inhabitants, on a territorial extent of 145 kilometres, and 29 communes.

**EVREGNIES**, a town of France, in the department of Jemmappe; nine miles N.N.W. of Tournay.

**EUREOS**, in *Natural History*, the name of a stone, described by Pliny, and seeming plainly to be the same with the *zeolithus*, which he mentions in another place, and to

be the stone now called *lapis Judaicus*; and known at this time to be the petrified spine of a sort of *echinus marinus*, or sea urchin.

**EVREUX, MEDIOLANUM, Eborice, or Civitas Eboracorum**, in *Geography*, a town of France, in the department of the Eure, of which it is the capital, and chief place of a district. Its north division contains 4200, and the canton 10,458 inhabitants, and the south division 4226, and its canton 10,853 inhabitants; the territorial extent comprehends 345 kilometres, and each division includes 30 communes. Before the revolution this was the see of a bishop, suffragan of Rouen; containing nine parish churches, two abbeys, and ten convents. This is an ancient and considerable town, with large suburbs, situated in a deep and fruitful vale on the river Eton, 23 miles N.W. from Paris. Its cathedral is a fine Gothic structure. The manufactures of Evreux consist of woollen and linen cloth, and its trade of rice, grain, wine, and cyder; but they are not considerable. N. lat. 49° 2'. E. long. 1° 15'.

**EURIA**, in *Ancient Geography*, a town of Greece, in Epirus.

**EURIPIDES**, in *Biography*, the contemporary and rival of Sophocles, and one of the most ancient Greek tragedians, was born in the isle of Salamis, in the first year of the 75th olympiad, B.C. 480, according to many writers, though the Arundelian marble places his birth five years earlier. His father's name was Mnesarchus, an Athenian, and that of his mother was Clito, a feller of herbs, according to the report of Aristophanes, the avowed enemy of Euripides; but by the testimony of later grammarians, founded on the authority of Philochorus, an ancient writer, she was of noble descent. Before the birth of his son, Mnesarchus is said to have consulted the oracle of Apollo concerning his future destiny, and to have received for answer, "that the child who should be born to him would reach the summit of glory, and gain the honour of the sacred garland," which was understood to signify the crown of victory at the olympic games. When Greece was invaded by Xerxes, Mnesarchus and his wife retired for safety, among other Athenians, to the island of Salamis. In the autumn of the year 480 B.C. when this invasion took place, the fate of Greece was in a great measure decided by the naval victory of Salamis over the Persians; and on the same day, it is said, Euripides was born, who in memory of this battle, fought in the narrow channel, or *Euripus*, which divides Salamis from the continent, received his name. Euripides, at subsequent periods of his life, was accustomed to frequent the island of his nativity, where was shewn a cave, in which some of his tragedies are said to have been composed. Euripides, in conformity to the suggestion of the oracle, and also to the custom of the country, qualified himself for honourable and successful contest at the public games, by an early initiation in the usual gymnastic exercises; but his views were directed to nobler pursuits. Accordingly, whilst he paid some attention to the art of painting, he studied rhetoric under Prodicus, celebrated for the allegory of the choice of Hercules, preserved by Xenophon, and received instructions in physics from Anaxagoras, and in morals from Socrates. In his 18th year he first applied himself to the composition of tragedies, the number of which, during the course of his life, amounted, as some say, to 75, but according to others, to 92. He does not appear, however, to have been very successful in his exhibitions on the theatre, for no more than five of his performances gained the prize at the olympic games; but they were privately read with avidity and highly applauded by his countrymen. To this purpose we may mention the following fact. After the

unfortunate expedition of the Athenians against Syracuse, several captives were kindly treated by the Sicilians, and obtained relief from indigence and wretchedness, by going about from place to place, reciting and singing the verses of Euripides. Upon their return to their own country, the poet received their personal acknowledgments. Socrates was the friend of Euripides, and is said to have given him advice and assistance in the composition of some of his dramas; and he occasionally attended the public exhibition of them. In the character of Palamedes the poet was supposed to have delineated that of Socrates; and some verses are quoted addressing the Greeks as having slain the best and wisest of their nation, which the audience applied to the fate of this philosopher, bursting into tears at the recollection of their crime. As Socrates had become an object of public persecution and calumny before the representation of the Palamedes, some application of the character to his circumstances might probably have been intended by the poet. But his death could only be alluded to by way of probable anticipation, as he survived Euripides some years. The remarkable effect ascribed to the passage of the Palamedes just mentioned might possibly have taken place at some representation of that play subsequent to the death of Socrates. Euripides was the constant rival of Sophocles, and their mutual jealousy seems to have degenerated into declared enmity. Our poet was frequently the object of raillery to Aristophanes. Euripides was twice married; but as he was disappointed in his expectation of domestic happiness, he is said to have indulged a kind of antipathy to women, for which this circumstance has been pleaded as an apology. Hence he obtained the name of *Μισογυνής*, woman-hater, though his editor, Barnes, strenuously defends him from the charge implied in this appellation, observing, that if he has described some females with all the vices incident to human nature, yet he has delineated many others with all the virtues that can adorn their sex; and Sophocles is said to have observed, that the hatred which he expressed against women was confined to the stage. In advanced life he enjoyed so little felicity at Athens, that he accepted an invitation to the court of Archelaus, king of Macedonia, where he was honourably treated, though he did not altogether escape the effects of malicious jealousy. To the consequence of a quarrel from this cause some have ascribed his tragical death; for as he was walking in a wood, the king's hounds were let loose upon him, and tore him in pieces. Others say that his death was owing to natural decay. He died at the age of about 75 years. The Athenians sent ambassadors to Macedonia, to request the removal of his body to his native country; but Archelaus refusing to comply with their request, caused him to be interred with great magnificence, and erected in honour of him a noble monument in the vicinity of Pella, his chief city. The Athenians appointed a public mourning on occasion of his death, and erected in memory of him a cenotaph on the road leading from the city to the Piræus. The following epitaph is ascribed to Thucydides, the historian.

“Μνημα μὲν Ἑλλάς ἄστια· Ἐυριπίδων· οὐρα δὲ σχη  
Γῆ Μακεδῶν, ἣ γὰρ δεξάλο τετρα βίου.  
Παῖς δ’ Ἑλλάδος Ἑλλάς Ἀθῆναι· πλεῖστα δὲ Μουσῆς  
Τετράς, ἐκ πολλῶν καὶ τοῦ ἑταίου ἔχει.”

“All Greece is the monument of Euripides; the Macedonian land possesses his bones, for there he reached the boundary of his life. His country is Athens, the Greece of Greece; having afforded general delight by his muse, he enjoys the recompence of general praise.”

It has been recorded to the reproach of Euripides, that

many of the maxims which he attributes to his dramatic characters are favourable to vice; and though he cannot be wholly exculpated from this charge, he abounds with moral maxims, expressed in noble and elegant language, which deeply impress the mind of the reader. He has been also charged with moroseness of temper; but however this be, he introduces numerous passages of tender and delicate pathos. As a tragedian, when compared with Sophocles, it seems to be the general opinion, that with less pomp of diction, less force and elevation of character, and less knowledge of dramatic effect than his rival, he more excels in tenderness, suavity, and moral sentiment. Aristotle calls him the “most tragical” of all the poets, meaning either that he was the most skilful in the drama, or the most pathetic. Euripides, it should be recollected, was the favourite poet of Milton. Possessing a high notion of the preceptive office of the theatre, he was once desired by the auditors to retrench a passage in one of his plays, but he stepped forward and said, “I do not write in order to learn from you, but to teach you.” Of his works nineteen complete plays, and the commencement of a twentieth, are still remaining. Of these, both singly and collectively, there are several editions. The best of the whole works are those of Basil, 1551, of Plantin, 1571, of Commelin, 1597, of Paul Stephens, 1604, 1611, of Barnes, *Camb.* 1694, and of Musgrave, *Oxf.* 1778. Bayle. Moreri. Barnes. Gen. Biog.

EURIPUS, *Εὐρίπος*, in *Hydrography*, properly signifies a certain strait of the sea which divides Eubœa from Attica, Bœotia, and Locris, where the currents are so strong that the sea is said to ebb and flow seven times a day; in which place, as the story commonly goes, Aristotle drowned himself out of chagrin, for not being able to account for so unusual a motion. This strait was so narrow over-against Chalcis as scarcely to admit a galley. It is now called the gulf of Negropont.

Euripus has since become a general name for all straits, where the water is in great motion and agitation.

The ancient circuses had their Euripi, which were no other than pits or ditches, on each side of the course, into which it was very dangerous falling with their horses and chariots as they ran races. The term Euripus was more particularly applied by the Romans to three canals or ditches which encompassed the circus on three sides, and which were filled occasionally, to represent naumachic or sea-battles.

The same people called their smaller fountains or canals in their gardens Euripuses; and their largest, as cascades, &c. *Niles*.

EUROCLYDON, of *Εὐρος*, east-wind, and *κλύδων*, wave, is a species of wind, of which we have an account only in Acts, xvii. 14. and concerning the nature of which critics have been much divided. Bochart, Grotius, Bentley, and others, substitute another reading, supported by the Alexandrian MS. and the Vulgate, viz. *Εὐρακίλων*, or *Euroaquilo*; but Mr. Bryant defends the common reading, and considers the Euroclydon, i. e. *Εὐρος κλύδων*, as an east-wind that causes a deep sea or vast inundation. He maintains, in opposition to Dr. Bentley's reasoning, who supposes that the mariners in the ship, the voyage of which is recited in this passage, were Romans, that they were Greeks of Alexandria, and that the ship was an Alexandrine ship, employed in the traffic of carrying corn to Italy; and therefore, that the mariners had a name in their own language for the particular typhonic or stormy wind here mentioned. He also shews from the passage itself, that the tempestuous wind called Euroclydon, beat (*κατ' αὐτῆς*) upon the island of Crete; and therefore, as this is a relative expression, referring to the

the situation of the person who speaks of it, who was at that time to the windward, or south of it, the wind blew upon shore, and must have come from the south or south-east; which, he adds, is fully warranted from the point where the ship was, and the direction it ran in afterwards, which was towards the north and north-west. Bryant's Observations, &c. 1767, p. 1. &c.

EURO-AUSTER. } See WINDS.  
EURO-Notus. }

EUROMA, in *Ancient Geography*, a town of Asia, in Phœnicia.

EUROMUS, a town of Asia, in Caria; situated E. of mount Grius, N. of mount Latmus, and N.W. of the town of Mylasa. It had a theatre and a magnificent temple.

EVRON, in *Geography*, a town of France, in the department of the Mayenne, and chief-place of a canton, in the district of Laval; 15 miles E.N.E. of Laval. This place contains 4044 and the canton 13,213 inhabitants, on a territorial extent of 205 kilometres and 11 communes. The fairs of this town are frequented.

EUROPA, in *Mythology*, daughter of Agenor, king of Phœnicia, by his wife Telaphassa, who was so beautiful, that, according to the fable, Jupiter is said to have fallen in love with her, and to have ordered Mercury to convey her to the sea-shore, where that god, having transformed himself into a bull, took her upon his back, and transported her into Crete. Some have explained this fable by alleging that a captain of Candia, named Taurus, carried off that princess, after he had taken the city of Tyre from Agenor; but others, with greater probability, assert, that some merchants of Crete, having arrived upon the coasts of Phœnicia, and seen the young Europa, were so much struck with her beauty, that they carried her off for their king Asterius; and as their ship bore upon the fore-castle a white bull, and that king of Crete had assumed the name of Jupiter, it was hence fabled that the god had transformed himself into a bull, in order to carry off the princess. Asterius is said to have married her, and to have had by her three sons; after which she is reported to have engaged the attachment and esteem of the Cretans to such a degree, that they worshipped her after her death as a divinity. They even instituted a feast in honour of her, which was called Hellotia. They afterwards gave her the surname of Minerva, and celebrated to her honour that festival which was consecrated to that goddess among the Cretans. Several authors have been of opinion that Europe took its name from this princess; but the learned Bochart believes that this part of the world was so denominated from the whiteness of its inhabitants. M. Gebelin, however, deduces the name of Europa from *Wrab*, signifying Occidental, and expressing its situation with regard to Asia.

EUROPA rocks, in *Geography*, rocks in the strait of Mozambique. S. lat. 21° 30'. E. long. 40° 16'.

EUROPE, one of the four grand divisions, or quarters, as they have been somewhat improperly called, of the terraqueous globe. Although Europe be less considerable in extent than Asia, or America, or even Africa, it claims on a variety of accounts our more particular attention. In modern times it has been the seat of literature and science; in this part of the globe every kind of cultivation and improvement has made the most rapid progress, and it has been distinguished, not only by the general temperature of its climate, the fertility of its soil, and the abundance of its productions for the supply of necessity and the gratification of luxury, but more especially for the wisdom, strength, and courage of its inhabitants, and for the excellence of its government, laws, and religion. The boundaries of

Europe were very inaccurately ascertained by the ancient geographers, and the name itself seems to have originated in a small district near the Hellespont. More than a third part of Europe, towards the north and east, has only been known with precision in modern times. It lies chiefly in the temperate zone, north of Africa, and north-west of Asia, between 35° 25' and 71° 23' N. lat. and between 9° 40' W. and 61° 5' E. longitude. From the Portuguese cape, denominated by our mariners the rock of Lisbon, in the west, to the Uralian mountains in the east, the length may be about 3,300 British miles; and the breadth from Cape Nord in Danish Lapland to Cape Matapan, the southern extremity of Greece, may be about 2,350. The contents in square miles have been variously estimated, but at a medium may be stated at about 2½ millions. On the south, Europe is bounded by the Mediterranean sea, on the west by the Atlantic, which contains the most remote European islands, the Azores and Iceland, Greenland being regarded as a part of North America. On the north the boundary is the Arctic ocean, comprehending the remote isles of Spitzbergen, and Novaya Zemlia, or the New Land. "Toward the east the limits, (says Mr. Pinkerton,) admit of some discussion: the Uralian mountains, a grand natural limit, not extending to the Arctic ocean, the river Kara, which flows into the sea of Karshoye, is admitted as a boundary. The Uralian limit extends to about 56° of N. latitude; to the south of which the grand confines of Europe and Asia have been sought in the petty distinctions of Russian governments. More natural limits might be obtained by tracing the river Oufa from its source, to its junction with the Belaisa. Thence along the Kama to the Volga, which would constitute a striking natural division, to the town of Sarepta; whence a short ideal line, the only one admitted in this delineation, will lead due west to the river Don, which would complete the unascertained boundary; that on the north and west of the Euxine being clear and precise."

The ancient inhabitants of Europe consisted of Celts in the west and south; Fins in the north-east; and Laps or Laplanders, resembling the Samoieds of Asia in the farthest north, who enriched their rude language by adopting that of the more civilized Fins. The ancient inhabitants, who seem to have been thinly scattered, were driven towards the west and north by the Scythians or Goths from Asia, whose descendants occupy the greater part of Europe; by the Sarmatians or Slavonic tribes, also from Asia, the ancestors of the Russians, Poles, &c. and who were accompanied by the Heruli, using what is now called the Lettic speech, to be found in Prussia, Lithuania, Samogitia, Courland, and Livonia, somewhat akin to the Slavonic language, with various shades of distinction. The colony of Iberi, northern Mauretani, passed into Spain at a very early period; and the later accession of Hungarians and Turks from Asia may likewise be commemorated. The present population of Europe is commonly estimated at 150,000,000; and though some writers have asserted that this quarter of the globe was anciently more populous than it is now, the opinion does not seem to be well founded. It will not readily be adopted by those who duly consider the number and magnitude of modern cities, towns, and villages; the abolition of feudal wars; the adoption of a mode of combat less destructive than that which formerly prevailed; the gradual extirpation of superstition, fanaticism, barbarity, and slavery; and the many extensive improvements made in agriculture, by eradicating forests, draining marshes, cultivating wastes, and opening canals of communication in the interior countries.

countries. It is generally allowed, that, notwithstanding the ravages of war, and emigrations to foreign parts, the population of most European states has been, for some time past, increasing. The prevalence of the Christian religion throughout Europe, except in some parts of Turkey, has been favourable to knowledge, industry, and civilization; and it has contributed to constitute the whole of Europe, as it were, into one republic, so that any useful discovery made in one state passes rapidly to the rest. The mutual intercourse between the different states of Europe is very much facilitated by its inland seas, as well as navigable rivers and canals. Of the inland seas the principal are the Mediterranean, the Baltic, and the White sea, which see respectively. Its other seas are the German, often styled the North sea, the Irish sea, and various parts of the Atlantic. The gulfs and bays of Europe are very numerous, among which we may reckon the following, *viz.* the Bothnian and Finland gulfs; the Murray frith, and Frith of Forth, on the east coast of Scotland; the bay of Biscay, a large inlet of the Atlantic, on the east bounded by France, and on the south by Spain; the gulfs of the Mediterranean, *viz.* that of Lyons, S. of France; that of Genoa, between Corsica and the Genoese republic; the gulf of Venice, between Italy and Greece; the gulf of Lepanto, N. of Morea; the Archipelago between Greece and Asia Minor; the sea of Marmara between Europe and Asia; and the sea of Azoph on the north coast of the Euxine. The most considerable straits are that of Waygatz at the N. E. extremity of Europe; the sound of Elsinore between the island of Zealand and Sweden; the Little Belt between Funen and Jutland; the Categat, or entrance into the Baltic; the strait of Dover, or English channel, between England and France; the Bristol channel, between England and Wales; St. George's channel, between Great Britain and Ireland; Pentland frith, between Scotland and the Orkney Isles; the strait of Gibraltar, between Spain and Africa; the strait of Messina, between Italy and Sicily; the Dardanelles strait, or south entrance into the sea of Marmara; the strait of Constantinople, that forms a communication between the sea of Marmara and the Euxine; and the strait of Caffa, between the Euxine and the sea of Azoph. The most remarkable capes are North Cape, the extreme point of Lapland; Cape Finisterre, on the N. W. coast of Spain; Cape St. Vincent, the S. W. extremity of Portugal; and Cape Matapau, the S. point of the Morea. Its principal lakes are those of Omega, Ladoga, and Peipus, in Russia; those of Geneva and Constance, S. W. and N. of Switzerland; Lago Maggiore, and others, in the northern parts of Italy. The largest rivers are the Volga, Don, and Dwina, in Russia; the Dnieper on the east border of Poland; the Danube, between Hungary and European Turkey; the Rhine and Elbe in Germany; the Rhone in France; the Po and Tyber in Italy; the Tago in Spain; the Scheldt and Meuse in the Netherlands; the Thames and Severn in England; the Tay in Scotland; the Shannon in Ireland, &c. &c. The principal chains of mountains are the Carpathian or Krapach mountains, between Poland and Hungary; the Alps, between France, Switzerland, and Italy; the Apennines, in Italy; the Pyrenées between France and Spain; and the extensive ridge that separates Norway from Sweden. The most distinguished islands are Great Britain and Ireland, the Orkney Isles, the Hebrides, Zealand, and Funen, in the Baltic; Iceland, in the North sea; and in the Mediterranean, Ivica, Majorca, Minorca, Sardinia, Corsica, Sicily, Malta, Candia, and the islands of the Archipelago.

The principal European states are the British empire, including England, Scotland, and Ireland; the states of Denmark, comprehending Denmark with the adjacent islands, Norway and Iceland; Sweden; Russia, formerly called Muscovy; Holland; France, including the Netherlands, Italian states, and other late acquisitions; Switzerland; Germany and Austria; Prussia; Bohemia and Hungary; Poland, now dismembered; Spain; Portugal; Sicily; Malta; and Turkey in Europe. See each under its appropriate title.

EUROPEAN HOURS. See HOUR.

EUROPEAN Ocean. See OCEAN.

EUROPUS, in *Ancient Geography*, a town of Asia, in Parthia, founded, as Strabo says, by Nicator, and called by the Parthians *Arfacia*.—Also, a town of Asia, in Syria, situated on the banks of the Euphrates, E. of Hieropolis, and S. of Zeugma.—Also, a town of Asia, in Caria.—Also, a town of Macedonia.—Also, a river of Greece, in Thessaly, which rose in mount Citarius, and flowed into the Peneus.

EUROTAS, a river of Laconia, which commenced on the frontiers of Arcadia, watered Sparta, and proceeding southward, discharged itself into the Laconic gulf.—Also, a river of Greece, in Thessaly, near mount Olympus.—Also, a river of Italy, near Tarentum, the same with the river Galefus, according to Polybius.

EURUS, in *Mythology*, the genius of the south-east wind, according to the Grecian division of the compass into eight points; but according to the Roman division into four, Eurus was the intelligence that presided over the whole eastern quarter of the heavens. (See WIND.) "Eurus," says Spence, "according to the Roman poets, seems to have his character composed from the Apeliotes and Eurus of the Greeks: by one description of him he should have a look that seems delighted, and in another he is spoken of as playful and wanton. He is sometimes described as impetuous, and sometimes as disordered with the storm he has been driving along the sea. Horace gives us a picture of the former, and Valerius Flaccus of the latter. I should be apt to imagine, from some expressions in the poets, that he was sometimes represented on horseback, or perhaps in a chariot, whirling through the air; but there are so few remains of the ancient artists relating to these airy beings, that we have nothing from them to confirm any such conjecture."

EURYA, in *Botany*, supposed to be from *euvs*, broad or ample, the application of which to this plant we do not, from any part of the description or figure, perceive. Thunb. Jap. 11. Schreb. 321. Willd. Sp. Pl. v. 2. 856. Mart. Mill. Dict. v. 2. Juss. 432. Class and order, *Dodecandria Monogynia*. Nat. Ord. uncertain, Juss.

Gen. Ch. Cal. Perianth inferior, of five ovate, concave, obtuse, small leaves, with two lesser ones at its base. Cor. Petals five, roundish-ovate, concave, the size of the calyx. Nectary a glandular ring round the base of the germen. Stam. Filaments thirteen, extremely short; anthers erect, square, almost as long as the corolla. Pist. Germen superior, roundish, smooth; style awl-shaped, shorter than the stamens; stigmas three, reflexed. Peric. Capsule globose, tipped with the permanent style, smooth, of five valves and five cells, scarcely so big as a pepper-corn. Seeds several, obscurely triangular, dotted, brown, destitute of pubescence. Obs. Thunberg observed the flowers to be most frequently dioecious.

Ess. Ch. Calyx double; the inner of five equal leaves; the outer of two smaller ones. Petals five. Capsule superior, of five cells and five valves. Seeds numerous.

*E. japonica*. Thunb. Jap. 191. t. 25. (Fisakaki; Kämpf. Amœn. Exot. 778.) A Japanese shrub, common on the hills about Nagasaki, flowering in September and October, and cultivated in gardens for the sake of its elegance. It is smooth in every part. Branches slender, alternate, leafy. Leaves alternate, stalked, elliptic-lanceolate with a blunt point, serrated, compared by Kämpfer to those of tea, evergreen, yellowish beneath, an inch or two long. Flowers axillary, in pairs, stalked, small, white or reddish. Thunberg describes the fruit as above; but Kämpfer says "the berries resemble those of juniper, and are juicy, giving a stain like ultramarine, and containing from ten to twenty hardish brown seeds, crackling under the teeth." If Thunberg adverted to this description, he might perhaps deduce the generic name, though incorrectly, from *eu*, *well*, and *juvus*, a flowing of juice, or a falling of berries.

**EURYALÉ**, in *Mythology*, one of the Gorgons, daughter of Phorcys, and sister of Medusa: she was subject neither to old age nor death.

**EURYAMPUS**, in *Ancient Geography*, a town of Macedonia, in Magnesia.

**EURYANDRA**, in *Botany*, from *euvs*, broad, and *andros*, a male, because the male organs, or stamens, are dilated at the summit. Forst. Gen. t. 41. Schreb. 367. Juss. 280. See **TETRACERA**; to which genus Schreber, in his emendanda, 833, and Willdenow, Sp. Pl. v. 2. 1242, have at the recommendation of Solander referred it.

**EURYDICE**, in *Mythology*, the wife of Orpheus, who, flying from Aritæus that endeavoured to ravish her, was slain by a serpent. Her husband went down to the shades, and by the force of his music persuaded Pluto and Proserpine to give him leave to carry back his wife; which they granted, provided he did not look on her till he came to the light; but he, breaking the condition, was forced to leave her behind him.

**EURYMEDON**, in *Ancient Geography*, *Zacuth*, a river of Asia, in ancient Pamphylia, which had its source in mount Taurus, passed the town of Aspenus, and discharged itself into the sea of Pamphylia.

**EURYMENÆ**, a town of Greece, in Thessaly.

**EURYNOME**, in *Mythology*, the mother of the three Graces.

**EURYNOMIA**, *Εὐρυνομία*, in *Antiquity*, an anniversary solemnity in honour of Eurynome, by some thought to be the same with Diana, by others one of Oceanus's daughters.

**EURYPHON**, the Cnidian physician, in *Biography*, was a contemporary of Hippocrates, but probably older in years, since he is deemed the author of the Cnidian aphorisms, which are quoted by Hippocrates. These two physicians are said by Soranus to have met in consultation in the presence of king Perdiccas. Euryphon is mentioned by Plato the comedian, as having produced many scars on the skin of Cinesias, the son of Evagoras, by the employment of actual cauteries for the cure of empyema, or pulmonary consumption; a practice which Hippocrates pursued. See Le Clerc Hist. de la Med.

**EURYTHMIA**, from *eu* and *ρυθμος*, order, an old term in *Surgery*, signifying adroitness in handling instruments.

**EURYTHMY**, *Εὐρυθμία*, in *Architecture*, *Painting*, and *Sculpture*, a certain majesty, elegance, and easiness, appearing in the composition of divers members or parts of a body, building, or painting, and resulting from the fine proportions thereof.

The word is Greek, and signifies literally a consonance or fine agreement, or, as we call it, a harmony of all the parts.

being compounded of *eu*, *well*, and *ρυθμος*, rhythmus, cadence, or agreement of numbers, sounds, or the like things.

Vitruvius ranks eurythmia among the essential parts of architecture; he describes it as consisting in the beauty of the construction or assemblage of the several parts of the work, which renders its aspect or whole appearance graceful; *e. gr.* when the height corresponds to the breadth, and the breadth to the length, &c.

"From these three ideas or designs, *viz.* orthography, scenography, and profile, it is that eurythmy, majestic, and *venusta species edificii*, do result, which creates that agreeable harmony between the several dimensions, so as nothing seems disproportionate, too long for this, or too broad for that, but corresponds in a just and regular symmetry, and consent of all the parts with the whole." Evelyn's Account of Archit. &c.

**EUSCOM**, in *Geography*, a river of Canada, which runs into lake St. Clair. N. lat. 42° 45'. W. long. 82° 25'.

**EUSDALE**, or **EYSDALE**, a small island on the W. coast of Scotland, noted for its quarries of slate. N. lat. 56° 13'. W. long. 5° 48'.

**EUSEBES**, the name of a species of marble mentioned by Pliny: he has given us no description of it, but only tells us, that there was a seat made of it in the temple of Hercules at Tyre, from which the priests pretended that the gods used to arise.

**EUSEBIANS**, a denomination given to the sect of Arians, on account of the favour and countenance which Eusebius, bishop of Cæsarea, shewed and procured for them at their first rise; or rather from the protection afforded to Arius, and the adoption of his opinions by Eusebius bishop of Nicomedia. See **ARIANS**.

**EUSEBIUS**, pope, in *Biography*, a native of Greece, son of a physician, perhaps he himself at one period was a physician, succeeded Marcellus in the see of Rome. It is believed that he filled the pontificate but a very few months. He was a violent opponent to the re-admission of lapsed Christians to communion, and his conduct on this head created great dissensions at Rome, to put an end to which the emperor Maxentius banished him to Sicily. Moreri. Bower.

**EUSEBIUS**, surnamed *Pamphilus*, was born at Cæsarea in Palestine, of which he was afterwards bishop, about the year 270. Of his parents, and his instructors in early life, we have no account; nor is any thing recorded concerning his family. His talents and learning may, however, be justly appreciated by his numerous and valuable works. Having been ordained presbyter, probably, by Agapius, bishop of Cæsarea, he set up a school in that city, which produced many learned men, and whilst he was in this situation he formed an intimate acquaintance and friendship with Pamphilus, a learned presbyter of the same church, who is supposed to have afforded him much assistance in his studies. When Pamphilus was imprisoned in the year 307, Eusebius attended him to animate his fortitude and comfort him in his distress: and after the martyrdom of his friend in 309, he removed to Tyre, where he witnessed the firmness and patience with which many Christians endured the severity of persecution. From thence he went to Egypt, where the same scene was exhibited, and where he himself was imprisoned. As he did not suffer in common with others, some persons have insinuated, that he procured his liberty by sacrificing, or by some other mean compliance, unbecoming his Christian principles and profession. But Dr. Lardner has alleged several circumstances which evince this accusation to be altogether unfounded. At the close of the Dio-

of the persecution, Eusebius returned to Palestine, and succeeded Agapius, according to the more general opinion, as bishop of Cæsarea in the year 315. It is certain, however, that he was bishop of Cæsarea in the year 320 at the latest. After this period he was present at most of the synods held in that part of the world; and on all occasions distinguished himself by recommending peace and mutual forbearance. At the famous council of Nice in 325, he was placed by command of Constantine on the right hand of the throne, and opened the meeting by a panegyric address. At this council he seems to have been desirous of compromising the dispute between Arius, to whose sentiments he probably inclined, and the orthodox party; and with this view proposed a creed, which all the fathers allowed to be unexceptionable. Some of the most zealous partizans, however, suggested the propriety of introducing the word *ὁμοουσιος*, or *consubstantial*, as applicable to the Son; and the motion for this purpose was carried by a majority. Eusebius for some time demurred, alleging that the expression was unscriptural; but at length, being allowed to subscribe to the term in his own sense of it, he submitted; and the word became afterwards the test of orthodox belief, but very ineffectual for allaying the dissensions of the Christian church. In the year 330 Eusebius concurred with the council at Antioch in deposing Eustathius the bishop; but though the bishops and people concurred in electing him for this see, which was more honourable and profitable than that of Cæsarea, he peremptorily refused the acceptance of it. Although they applied to Constantine for the interposition of his authority, Eusebius wrote to the emperor, and obtained his permission to decline it, accompanied with encomiums on his moderation and disinterestedness, which he justly merited. At the council of Tyre in 335 he joined those bishops who condemned the proceedings of Athanasius, bishop of Alexandria; and he was deputed to attend the emperor, in order to justify the measures that had been adopted against that prelate. On occasion of this visit to Constantinople, he pronounced his panegyric on the emperor, and obtained singular marks of Constantine's condescension and favour. After his return to Cæsarea, the emperor kept up an epistolary correspondence with him, specimens of which are preserved in Eusebius's life of that prince. This work was written soon after the death of the emperor; nor did the bishop long survive, for he died in the year 339 or 340. Of the learning and application of Eusebius, his works afford ample evidence. "From his works it appears," says Tillemont, "that he had read all sorts of Greek authors, whether philosophers, historians, or divines, of Egypt, Phœnicia, Asia, Europe, and Africa." Eusebius had opportunities for conversing with the most learned men of his time, and he had access to the best libraries: so that from these different resources he was able to compile works of various kinds, in which he exercised a laudable caution with respect to his authorities and facts, and in which he also manifests a considerable degree of candour and impartiality. His works, however, as compositions, claim no very high commendation, as they are destitute of elegance and perspicuity. Upon the whole we may observe, that he was a good man as well as a learned scholar; zealously attached to religion, without bigotry; an enemy to ecclesiastical tyranny and discord, and always desirous of accommodating differences, and reconciling contending parties. Nevertheless Dr. Lardner mentions with disapprobation his concurrence with the Arian party in the harsh treatment given to Eustathius, bishop of Antioch, Athanasius of Alexandria, and Marcellus of Ancyra. As to his sentiments

with regard to the doctrine, warmly controverted in his time, Dr. Jortin inclines to think, that he was neither an Arian nor an Athanasian, but that he endeavoured to steer a middle course, and yet inclining more to the Arians than to the Athanasians. Dr. Lardner, with his usual caution, observes, that this is a question which cannot be easily decided.

Of the works of Eusebius we can here enumerate only the principal, referring for an account of the rest to the writers cited at the close of this article. The first that deserves mention is the "Ecclesiastical History," in ten books, published in 326, and containing the history of the Christian church from the birth of Christ to his own times. The best edition is that of Valesius, published at Cambridge by Reading in three volumes folio. This contains Eusebius's "Life of Constantine," in four books, written in 337 or 338, and other ecclesiastical historians, Socrates, Theodoret, &c. In this history we have several passages concerning the canon of scripture; in which the author treats of the order of the gospels; of the scriptures universally acknowledged, and of those that are not such; of the epistles, &c. (See CANON.) Eusebius's "Chronicle" was a work of prodigious labour and learning, and is preserved only in a Latin version of Jerome. The "Evangelical Preparation," in 15 books, and ten books of the "Evangelical Demonstration," which originally comprehended 20 books, are still extant; and contain the most learned defence of Christianity against both Jews and Pagans, transmitted to us from antiquity. A beautiful edition of these valuable works was published in Greek, by Robert Stephens, in 1544 and 1545, in 2 vols. fol., and reprinted at Paris, in 1628, in 2 vols. fol., with a Latin version of the former, and various readings from different MSS. and notes by Francis Vigerius, and Donatus's Latin version of the latter. Eusebius was also the author of a "Commentary upon the 150 Psalms," published by Montfaucon in 1705, as far as the 119th psalm: "A Commentary upon the Prophecies of Isaiah," published likewise by Montfaucon: "An Exposition of the Song of Songs," published by Meursius in 1627; "A Treatise against Hierocles" who had made a comparison of Apollonius Tyaneus with Jesus Christ, still extant in the original Greek; "Two books against Marcellus," who revived the heresy of Sabellius, and "Three books of Ecclesiastical Theology," written in 336; "An Apology for Origen," in 6 books, the joint work of Eusebius and Pamphilus, now existing in a Latin version; "Ten Evangelical Canons," or rules for harmonizing the gospels; the "Topics," in two books, being a kind of dictionary of places mentioned in the Scriptures; "A description of the Church of the Sepulchre at Jerusalem, &c." composed in 335; "An Oration in praise of Constantine," which is as much an argument for the truth of the Christian religion, as a panegyric upon the emperor, and much commended by Du Pin and Lardner; the "Life of Constantine," in 4 books, already mentioned: "Fourteen small pieces in Latin," published by James Sirmond in 1643, 8vo. and many other treatises, that are no longer extant. Fabr. Bibl. Græc. v. vi. Cave's H. L. vol. i. Lardner's Works, vol. iv. Jortin's Rem. on E. H. vol. ii.

EUSEBIUS, first of all bishop of Berytus in Phœnicia, and afterwards of Nicomedia, in Bithynia, was advanced to the see of Constantinople in 338 or 339. He was a relation of the emperor Julian, who was educated by him, and probably also of Constantine: and as he was a man not only distinguished by his abilities and learning, but favoured with free access to the court, his influence on behalf of the Arian

party,

party, to which he was attached, was always of great importance to their cause. From the protection afforded to Arius and his followers by Eusebius they were frequently denominated "Eusebians." Although he remonstrated against the proceedings of the court of Nice in 325, at which he was present, he subscribed the creed, probably with the same explanation which was given by the bishop of Cæsarea of the same name. That this was the case we may infer from the patronage which he afforded to the Arians, and which caused Constantine to depose him from his see and to send him into exile. He was afterwards, *viz.* in 328 or 329, recalled, and restored to his see, as well as to the favour of the emperor. Afterwards, when the Arian party became triumphant at the court of Constantinople, he encouraged the persecution of those who had been the persecutors of Arius. Having maintained his credit and influence with Constantine till his death, he gained in an equal, if not greater, degree, the confidence of his son Constantius; who promoted him, in 338, to the see of Constantinople. In this high station he was active in promoting the Arian interests, and in persecuting the Catholics. Soon after the council of Antioch, held in 341, probably in the same or the succeeding year, he terminated his career. Eusebius was eminent for his abilities and learning; and his friends have extolled his piety and virtue: but no sufficient apology can be offered for his intolerance. His writings were numerous, but none of them remain, except a "Letter concerning Arius and his Opinions," preserved by Theodoret. Fabr. Bibl. Græc. vol. vi. Cave's H. L. vol. i. Lardner's Works, vol. iv.

EUSEBIUS, bishop of Emesa, who flourished about the year 340, was descended of a very honourable family, and born at Edeffa in Mesopotamia, at which place he enjoyed the benefit of a learned education, and of early instruction in the sacred scriptures. He afterwards removed to Palestine, where he studied under Patrophilus of Scythopolis, and Eusebius of Cæsarea. He likewise went to Antioch, and from thence to Alexandria, in which city he studied philosophy, and then returned to Antioch. Some time after that, having refused the offer of the see of Alexandria, from which Athanasius was deposed in 341, he was appointed bishop of Emesa; where his distinguished proficiency in literature and the sciences led the ignorant populace to charge him with the practice of magical arts. Under this accusation, he was obliged to retire to Laodicea, and to seek the protection of George, bishop of that city, who was afterwards his biographer. When the prejudices of the misguided people at Emesa subsided, he returned thither, and here he spent the greater part of the remainder of his life, which terminated at Antioch about the year 360. He is generally thought to have embraced the Arian tenets: though Cave thinks that he should be ranked among the Semi-Arians. However this be, his character was held in high estimation for virtue and piety, as well as for learning and eloquence. Although he was great and good, as Sozomen says, he experienced the envy of those who are offended at other men's virtues. The emperor Constantius, however, was much pleased with him, and his attendance was always required by that prince in his expeditions against the Persians. He wrote a great number of books, which were chiefly treatises against the Jews, against the Novatians, and against the Manichæans; 10 books upon the epistle to the Galatians; and many short homilies upon the gospels. His works are in general lost. His treatise against the Jews is said to be still extant in a Greek MS. in the library at Vienna. The homilies, that have been published under his name at Paris in 1575, and at Antwerp in 1602, 8vo.

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are now allowed to be the productions of other writers. Socr. Hist. Eccl. l. iii. Cave's H. L. vol. i. Lardner's Works, vol. iv.

EUSEBIUS, bishop of Verceil, or Vercelli, in Italy, was born in Sardinia; and flourished about the year 354. In this year he was deputed by pope Liberius to plead the cause of Athanasius, after his expulsion from Alexandria, before the emperor Constantius; and in the council at Milan he was a zealous advocate for the deposed bishop, and for the Nicene creed. The Arian party, however, prevailed, and a decree was passed for condemning the conduct of Athanasius. Eusebius resisted, and for his unyielding steadiness he was banished to Scythopolis in Syria, afterwards to Cappadocia, and last of all into the Upper Thebais. The cause of orthodoxy, notwithstanding all his sufferings, found him an undaunted and persevering advocate. Upon the accession of Julian to the empire, he and other friends were allowed to return home; and during the remainder of his life he maintained his invincible attachment to the Catholic doctrine, and his zeal in promoting it. He died about the year 370, or soon after. Most of his works have been lost: but it is said that in the cathedral church at Verceil there is a MS., containing a Latin version of the four Gospels, which is inserted in the "Evangeliarium Quadruplex Latinae Versionis Antiquæ, seu veteris Italicæ," published by Joseph Bianchini, at Rome, in 1749. Cave's H. L. vol. i. Lardner's Works, vol. iv. chap. 90.

EUSEBIUS, bishop of Dorylæum in Phrygia in the fifth century, was at first an eminent advocate at Constantinople, but embracing the ecclesiastical life, he obtained the above-mentioned see, and distinguished himself by his opposition to the Eutychians. Some few of his works remain, which are of a polemical nature, and not worth mentioning. Cave's Hist. Lit. vol. i.

EUSENE, in *Ancient Geography*, a town of Asia, in Paphlagonia. Ptolemy.

EUSHAR, in *Geography*, a town of Asiatic Turkey, in Natolia; 24 miles E. of Isbarteh.

EUSHEIM, a town of Germany, in the principality of Wurzburg; 3 miles N.W. of Volckach.

EUSIMARA, in *Ancient Geography*, a town of Asia, in Melitené, a country of Cappadocia, seated on the bank of the Euphrates. Ptolemy.

EUSKIRCHEN, in *Geography*, a town of France, in the department of the Roer; 20 miles S.E. of Juliers.

EUSTACE, or EUSTATIA, an inconsiderable American island, about 20 miles in circuit, forming with a long point of land the entrance to the harbour of St. Augustine, in East Florida. It was also called Metanzas, or Slaughter, from a butchery made upon it by the Spaniards.

EUSTACHE, DAVID, in *Biography*, a French protestant minister, at Montpellier, assisted at the national synod held at London in 1659, as deputy of the province of Lower Languedoc, and was nominated by the assembly to present to the king the letter which they had addressed to him. He performed the task much to the satisfaction of those who had appointed him to the office. He was author of many theological pieces and sermons; the titles of some of the former are "Salutary Remedies against a Departure from God;" "The Triumph of Faith;" "An Answer to the Question asked of the Protestants, where was your Church before Luther;" "The Orator Tertullus convicted;" which was a reply to the harangue supposed to be made by the wise men of the pretended reformed religion to the queen Maria Theresa, upon her entrance into the kingdom, in which they declared that being informed she had expressed great concern that part of the king her husband's subjects

were heretics; they came to lessen that concern by embracing her majesty's religion, and that this they did after having been satisfied, by the testimony of their most famous authors, that one may be saved in the Romish religion. Moreri. Bayle.

**EUSTACHIAN TUBE**, in *Anatomy*, is the passage by which air is conveyed from the fauces to the tympanum of the ear, so called from an Italian anatomist. See **EAR**.

**EUSTACHIAN valve**, is a part formed in the right auricle of the heart. See **HEART**.

**EUSTACHIUS**, **BARTHOLOMEW**, in *Biography*, one of the most celebrated anatomists of the sixteenth century, was a native of a little village in Italy, called San Severino. He pursued his studies at Rome, where he first conceived a bias in favour of medicine, and especially of anatomy, which he cultivated with such success, that he was appointed to the professor's chair in that college. This is nearly the sum of our knowledge respecting the life of this celebrated man: he died at Rome in 1574. Eustachius was the author of several works, the greater part of which is lost. His treatise "De Controversiis Anatomicorum," which was one of the most considerable of his productions, is much regretted. Those of his writings, which remain, consist of his *Opuscula*, which appeared under the following titles, "Opuscula Anatomica, nempe de Renum structura, officio, et administratione: de auditus organo: officium examen: de motu capitis: de vena quæ azygos dicitur, et de alia, quæ in flexu brachii communem profundam producit: de dentibus." Venet. 1563, and again in 1674, with the notes of Pinus. An edition was also published at Leyden, 1707, under the superintendance of Boerhaave.

Eustachius was the author of several discoveries in anatomy; he was the first who described the renal capsules, and the thoracic duct; and his name, still attached to the passage leading from the throat to the internal ear, (the Eustachian tube,) announces the origin of our knowledge on that subject. A series of figures engraved on copper were mentioned in his *Opuscula* as nearly finished; but they were lost for more than 150 years, and were discovered, and published at Rome in 1714, by Lancisi, physician to pope Clement XI. in one volume folio. These plates were again published, but not well printed, at Geneva in 1717. The edition of Rome in 1728 is excellent; but the one published at the same city, 1740, by Petrioli, is less valuable. The same work was twice published at Leyden, under the direction of Albinus, viz. in 1744 and 1762.

Eustachius edited the lexicon of Erotian at Venice in 1666, under the title of "Erotiani, Græci scriptoris vetustissimi, vocum, quæ apud Hippocratem sunt, collectio, cum annotationibus Eustachii," in 4to. Eloy. Dict. Hist.

**EUSTATHIANS**, in *Ecclesiastical History*, a name given to the Catholics of Antioch in the fourth century, on occasion of their refusal to acknowledge any other bishop beside St. Eustathius, bishop of Sebaste in Armenia, deposed by the Arians.

The denomination was given them during the episcopate of Paulinus, whom the Arians substituted for St. Eustathius, about the year 330, when they began to hold their assemblies apart. About the year 350, Leontius of Phrygia, called the Eunuch, who was an Arian, and was put in the see of Antioch, desired the Eustathians to perform their service in his church; which they accepted; and the church of Antioch served indifferently thus both for the Arians and Catholics.

This, we are told, gave occasion to two institutions, which have subsisted in the church ever since; the first was

psalmody in two choirs; though Mr. Baillet thinks, that if they instituted an alternate psalmody between two choirs, it was between two Catholic choirs, and not by way of response to an Arian choir. The second was the doxology, *Glory be to the Father, and the Son, and the Holy Ghost*.

This conduct, which seemed to imply a kind of communion with the Arians, gave great offence to abundance of Catholics, who began to hold separate meetings, and thus formed the schism of Antioch. Upon this the rest, who continued to meet in the church, ceased to be called Eustathians; and that appellation became restrained to the dissenting party.

St. Flavianus, bishop of Antioch, in 381, and one of his successors Alexander, in 482, brought to pass a coalition or re-union between the Eustathians and the body of the church of Antioch, described with much solemnity by Theodoret, Eccl. lib. iii. cap. 2.

**EUSTATHIANS** were also a sect of heretics in the fourth century, denominated from their founder Eustathius, a monk so foolishly fond of his own profession, that he condemned all other conditions of life. Whether this Eustathius was the same with the bishop of Sebaste and chief of the Semi-arians, it is not easy to determine.

He excluded married people from salvation; prohibited his followers from praying in their houses, and obliged them to quit all they had as incompatible with the hopes of heaven.

He drew them out of the other assemblies of Christians to hold secret ones with him, and made them wear a particular habit; he appointed them to fast on Sundays; and taught them that the ordinary fasts of the church were needless, after they had attained to a certain degree of purity which he pretended to. He shewed great horror for chapels built in honour of martyrs, and the assemblies held therein.

Several women, seduced by his reasons, forsook their husbands, and abundance of slaves deserted their masters' houses.

He was condemned at the council of Gangra, in Paphlagonia, held between the years 326 and 341. Socr. lib. ii. cap. 43 and Sozom. lib. iv. cap. 24. Hard. Concil. Coll. tom. i. p. 530.

**EUSTATHIUS**, in *Biography*, a saint in the Greek and Roman churches, and bishop of Antioch, was translated to that see from the bishopric of Beræa, in Syria, about the year 323. He was a strenuous opponent of the Arian doctrine, and is said to have been the first ecclesiastic of consequence who wrote against it. He was distinguished by his zeal at the council of Nice in 325, and by his exertions in carrying the decisions of that council into effect. This conduct so much exasperated the Arian bishops, that they got him accused of adhering to the doctrine of Sabellius, rather than to that of the council of Nice. His enemies also suborned an infamous woman to appear before the synod of the Eastern bishops, to charge Eustathius with being father of a child which she held in her arms: other charges, equally disreputable, were made against him: of these he was declared guilty, and deposed from his pastoral office. He was afterwards banished to Trajanopolis in Thrace, where he died. Of his numerous writings we have few remains, excepting the fragments collected by Fabricius. Jerome thought highly of his talents; Sozomen commends him for his piety and eloquence, and says that his works were in high estimation in his time. By Theodoret he is called the great Eustathius: but Socrates and others speak very slightly of his talents, and Socrates says he is one of those obscure persons who had endeavoured to raise his own reputation

reputation by opposing Origen. He is generally admitted to have been the author of "A Dissertation concerning the Ventriloquist or Pythoness," mentioned in Samuel, first book, chap. xxvii. written against Origen on that subject. This was published by Alladius in Greek, with a Latin version, in 1629, and may be found in the 29th volume of the "Bibliotheca Patrum," and in the eighth volume of the "Critici Sacri." Fabr. Bib. Græc. vol. viii. Cave's H. L. vol. i. Lardner's Works, vol. iv.

EUSTATIA, or EUSTATIUS, *St.*, in *Geography*, one of the leeward Caribbee islands; which is a huge pyramidal rock rising out of the sea, about 29 miles in compass; but for its size the Dutch, by their industry, rendered it one of the most valuable of the Caribbees. The sides of the mountains are laid out in pretty settlements; but they have neither springs nor rivers. Sugar and tobacco have been the chief produce of this island, which the Dutch have cultivated even to the top of the pyramid, which terminates in a plain surrounded with woods, having a hollow in the middle that serves as a den for wild beasts. This island has afforded subsistence for five thousand white people, and fifteen thousand negroes, who rear hogs, kids, rabbits, and all kinds of poultry in such abundance, that they have been able to supply even their neighbours. It has but one landing place, which the original occupiers, finding difficult of access, fortified, so as to render it almost impregnable. Such for many years was the policy of the Dutch in the government of this island, that they have been jealous of admitting any strangers into their harbour, and kept them ignorant of its internal riches, whilst it has served as a storehouse for all European commodities. The property of it was first granted by the States-General to certain merchants of Flushing. It was first settled about the year 1600; but in the wars between the English and Dutch in 1665, the latter were dispossessed of it by an armament from Jamaica. The English were afterwards dispossessed by the combined forces of the Dutch and French; and the latter kept possession of it till it was restored to the Dutch by the treaty of Breda. Soon after the revolution, the French ejected the Dutch from this island, whence they were again driven by the English under sir Timothy Thornhill, who, with a view to the protection of the Dutch, left a small English garrison in the fort. The peace of Ryswick restored the Dutch to the entire possession of the island. In the year 1781 this island was obliged to surrender to the English under admiral Rodney, who confiscated the private property of the inhabitants under a plea that they had assisted France and the United States with naval and other stores. Before the close of the year it was retaken by the French under the command of the marquis de Bouille; but restored to the Dutch at the peace in 1783. It is distant 9 miles N. W. from St. Christopher's. N. lat. 17° 30'. W. long. 63° 8'.

EUSTATIA, is also the name of a town in the fore-mentioned island.

EUSTATIUS, in *Biography*, archbishop of Thessalonica, flourished in the 12th century, under the emperors Manuel, Alexius, and Andronicus Comnenus. He is celebrated for his great learning as a grammarian and critic, and is especially known as a commentator on Homer and Dionysius the geographer. His annotations on the former are copious, and abound in historical and philological descriptions: they were published at Rome in four volumes folio, between the years 1542 and 1550, and have been re-printed, particularly at Florence in 1730, with the notes and translations of Politi and Salvini. The commentaries on Dionysius were first printed in the Greek, by Robert Stephens in 1547, and have been several times re-printed. A Latin

version of them was given by Politi in 1742, at Geneva, in two volumes octavo. Moreri.

EUSTEPHIA, in *Botany*, *ωσφως*, wearing a beautiful crown, alluding to the coronet formed in the mouth of the flower, by the transverse segments of the stamens. Cavan. Ic. v. 3. 20. Willd. Sp. Pl. v. 2. 48. Vent. Regn. Veg. v. 2. 282. Class and order, *Hexandria Monogynia*. Nat. Ord. *Spathacea*, Linn. *Narcissi*, Juss.

Gen. Ch. *Cal.* Sheath oblong, divided to the base into four acute segments, withering. *Cor.* superior, of one petal, tubular, regular, in six deep, linear, obtuse, nearly equal segments, three of which are internal; without any appendage at the mouth. Nectary six little cavities in the base or tube of the corolla. *Stam.* Filaments six, inserted into the bottom of the corolla, just above each nectariferous pore, linear, flat, somewhat longer than the corolla, and three-cleft just where they emerge from it, the middle segment longest, erect, slender, bearing the anther, the lateral ones short, and horizontally divaricated, forming a crown in the mouth of the corolla; anthers incumbent, ovate. *Pist.* Germen inferior, turbinate, triangular; style thread-shaped, the length of the stamens; stigma swelling, undivided. *Peric.* as far as can be judged from the germen, a capsule of three cells. *Seeds* . . .

Eff. Ch. Calyx a divided sheath. Corolla superior, regular, tubular, cylindrical, in six deep segments. Nectary six pores in the base of the corolla. Filaments with two lateral points.

1. *E. coccinea*, Cavan. Ic. t. 238. Flowered in the royal garden at Madrid in May 1794, but its native country is unknown. *Root* perennial, bulbous. *Leaves* radical, several, linear, obtuse, somewhat falcated. *Stalk* solitary, above a foot high, stout, smooth, slightly compressed. *Flowers* four in a terminal umbel, drooping, scarlet, resembling those of *Cyrtanthus angustifolius*, but very distinct in their structure. *Sheath* nearly as long as the partial flower-stalks and flowers together.

EUSTOCHIUM, or EUSTOCHIA, in *Biography*, a Roman lady in the 4th century, who is highly spoken of by St. Jerome, was a descendant from the families of the Scipios and Paulus Æmilii, and rendered herself celebrated for the proficiency which she had made in literature. She was well acquainted with the Hebrew and Greek, as well as the Latin tongues, and conversant with the most important theological subjects. In the Catholic world her memory is cherished on account of her early devotedness to a religious course. She professed herself a disciple of St. Jerome, whom she followed from Rome to Cyprus, and thence to Antioch, Egypt, and numerous other places, and at length fixed her residence in a monastery at Bethlehem. Her mother Paula deserted a young family to accompany her in these excursions. Moreri.

EUSTRATIUS, a presbyter of the church of Constantinople, flourished about the year 578, and was author of "A Treatise concerning the Souls of the Dead," intended to prove that the souls of all men are active after their separation from the body, and that they act differently according to the difference of their merits. He was author also of "The Life of the Patriarch Eutychius," which appears to have been a funeral oration pronounced by Eustratius in the great church at Constantinople, a short time after the death of the subject of it.

EUSTRATIUS, archbishop of Nice in the twelfth century, is mentioned by Anna Comnena, and other Latin writers, as a person of profound learning and skill, as well in civil as ecclesiastical affairs. He was author of "A Treatise against Chrysolanus concerning the procession of the

Holy Spirit," and of other unpublished treatises. The only works of his which have been committed to the press are "Commentaries on the latter Analysis of Aristotle," published in Greek at Venice, in 1534; and "Commentaries on the Ethics of Aristotle," published likewise in Greek at the same place, 1536, and at Paris in Latin, 1543. Moreri.

**EUSTYLE**, formed of *eu*, *bene*, *well*, and *στυλος*, *column*, in *Architecture*, a kind of edifice, where the columns are placed at a most convenient distance one from another, the intercolumniations being all just two diameters and a quarter of the column, except those in the middle of the fronts, before and behind, which are three diameters distant.

The eustyle is a medium between the pycnostyle, and areostyle.

Vitruvius, lib. iii. cap. 2 observes, that the eustyle is the most approved of all the manners of intercolumniation, and that it surpasses all the rest in conveniency, beauty, and strength.

**EUTACA**, in *Geography*, a mountain of Egypt, near the Red sea; 12 miles S. of Suez.

**EUTAM**, a small island of the West Indies, near the east coast of Porto-Rico. N. lat. 18° 18'. W. long. 64° 41'.

**EUTERPE**, in *Botany*, *εὐτερπη*, *pleasing or agreeable*. Gært. v. 1. 24. t. 9. Juss. 453. Supposed by Jussieu to be the same with his *Corypha Sabal*, see our *ΚΟΡΥΦΗ*, sp. 3, which Adanson likewise made a distinct genus. If it be so, Gærtner's classical appellation may well take place of the barbarous Sabal.

**EUTERPE**, of *eu*, *well*, and *τερπη*, *I delight*, in *Mythology*, one of the nine Muses, which presided over wind-instruments: she is represented with a crown of flowers, playing on a double flute, with Cupid at her knees. Sometimes she has a mask in her left hand, and a club in her right. To her the invention of tragedy is ascribed.

**EUTHIA**, a term in the *Ancient Music*, which implies a succession of notes proceeding from grave to acute. Euthia was one of the parts of the ancient Melopœia.

**EUTHYMIA**, *Εὐθυμία*, among the Greeks, signified such a disposition or state of the mind, as could not be ruffled either by good or bad fortune, by sickness or health, good or evil. Mem. Acad. Inscript. vol. xiv. p. 131.

**EUTHYMIUS**, in *Biography*, flourished in the tenth century, first as a monk, and afterwards, by his talents and virtues, he so far recommended himself to notice, that he obtained the appointment of "Syncelle," an office of high rank under the patriarch, and he was also chosen confessor by the emperor Leo VI. In 906 the patriarch Nicholas was deposed by the emperor, and Euthymius was elevated to it in his stead. Upon the death of Leo, his successor Alexander II. re-established Nicholas in the patriarchal chair, and sentenced Euthymius to banishment, a punishment which he bore with fortitude and patience till his death; in or about the year 920. Another patriarch of Constantinople, of the name of Euthymius, obtained that dignity in the year 1410, and enjoyed it till his death in 1416. Moreri.

**EUTHYMIUS ZIGABENUS**, was a monk of the order of St. Basil, who flourished at Constantinople about the beginning of the twelfth century. By his superior talents he acquired the patronage and esteem of the emperor Alexius Comnenus, at whose command he drew up his Panoplia, or defence of the orthodox faith against all heresies. It consists chiefly of passages selected from the writings of the ancient Greek fathers on different points, in which heretics have departed from the Catholic doctrine. Euthymius was

also the author of "A Commentary upon the Psalms and Canticles," of which a Latin version was published by Saulius in 1530, and since that time more than once reprinted: "A Commentary on the four Evangelists," selected from the ancient fathers; "Commentaries on the Epistles of St. Paul;" "A Treatise against the Heresies of the Massilians, &c." Moreri.

**EUTHYPOROS**, from *εὐθύ*, *straight*, and *πορίζω*, *to pass into*, among the old terms of *Surgery*, meant extension; made in a straight line, in order to reduce fractures, and dislocation.

**EUTIN**, in *Geography*, a town of Germany, in the bishopric of Lubeck, situated by the side of a lake, the usual residence of the prince bishop, the bishopric, like that of Osnaburg, being secular; 20 miles N. of Lubeck. N. lat. 54° 10'. E. long. 10° 32'.

**EUTOCIUS**, in *Biography*, a considerable mathematician, who lived at the time of the decline of the sciences in Greece, was a native of Ascalon, in Palestine, and a disciple of Isidorus, one of the celebrated architects employed by the emperor Justinian. He probably flourished about the commencement of the sixth century, though we have no particulars respecting his life; but his works reflect much honour on his memory. He wrote elaborate and perspicuous "Commentaries on the books of Archimedes concerning the Sphere and Cylinder;" and also on the first four books of the Conics of Apollonius Pergæus. These commentaries have not only elucidated many difficult passages in those profound writers, but have tended to throw light on the history of mathematics. There have been many editions of them, but the most magnificent was that in the edition of the works of Archimedes, printed at Oxford in folio, in the year 1792, which was prepared for the press by Torelli of Verona; and that in Dr. Halley's edition of the eight books of Apollonius, published at Oxford in 1710. Moreri. Montucla.

**EUTROPIUS**, a Latin historian of the fourth century, is supposed to have been a native of Aquitain. He bore arms under Julian, in his expedition against the Persians, and is said to have risen to the senatorian rank. He wrote several works, of which the only one remaining is an abridgement of the Roman history, in ten books, from the foundation of the city to the reign of the emperor Valens. This is a neat compendium, and has long since been received as a school-book. Moreri.

**EUTROPIUS**, the eunuch minister of the emperor Arcadius, who rose by base and infamous practices from the vilest condition to the highest pitch of opulence and power, was probably a native of Asia. In the year 395 he was made great-chamberlain to Arcadius, emperor of the East. After the fall of Rufinus, he succeeded that minister in the confidence of his master, and rose to unlimited authority: All persons of whatever rank humbled themselves before the favourite, who became the capricious disposer of honours and emoluments of every kind, and in 399 he, an eunuch, even assumed the dignity of consul, a disgrace to Rome never before equalled. Honours, if such they may be denominated, of every kind were accumulated upon him: the towns were filled with his statues, and he was entitled the third founder of Constantinople. His predominant passion was the love of money, and of course the most shameful venality directed all appointments to the high offices of the state. As a security to his person, a law of treason was passed, which extended the penalties of that crime to every attempt against the ministers and servants, as well as against the person of the emperor. Such a shield was not sufficient to defend him from the influence of court intrigue. An insult

sult which he offered to the empress caused her to implore the protection of her husband, and at the same moment complaints were offered against him from other quarters, which induced the emperor to sign his condemnation, and the fallen and justly execrated favourite was obliged to seek refuge in the sanctuary of a church, from the pulpit of which Chrysostom pronounced an eloquent discourse, pointing him out to the people as an example of the instability of human grandeur. He afterwards surrendered himself on promise that his life should be spared, and was condemned to perpetual exile in Cyprus. Thither he was conveyed, but being hastily brought back and tried on another charge, he was condemned and beheaded in the year 399. Gibbon.

EUTYCHIA, in *Ancient Geography*, an island of the Ægean sea, before the Pagasai gulf.

EUTYCHIANS, in *Ecclesiastical History*, ancient heretics, who denied the duplicity of natures in Christ; thus denominated from Eutyches, the archimandrite, or abbot of a monastery at Constantinople, who began to propagate his opinion A. D. 448.

The aversion Eutyches bore to the heresy of Nestorius threw him into another extreme not less dangerous than that he so warmly opposed; though some passages in St. Cyril, which raised the unity of the person of Jesus Christ very high, contributed likewise to his delusion. At first he held that the *Logos, Word*, brought his body down with him from heaven; which was a near approach to the heresy of Apollinarius; and, though he afterwards testified the contrary, in a synod at Constantinople, wherein he was condemned, yet he could not be brought to acknowledge that the body of Jesus Christ was consubstantial with ours.

In effect, he did not seem quite steady and consistent in his sentiments; for he appeared to allow of two natures, even before the union; which was apparently a consequence he drew from the principles of the Platonic philosophy, which supposes a pre-existence of souls; accordingly he believed that the soul of Jesus Christ had been united to the divinity, before the incarnation; but then he allowed no distinction of natures in Jesus Christ since his incarnation.

See the dissertation of H. Hardouin, "De Sacramento Altaris;" wherein that Jesuit endeavours to unfold all the sentiments of the Eutychians.

This heresy was first condemned in a synod held at Constantinople, by Flavian, in 448, approved by the council of Ephesus, called *Conventus latronum*, in 449, and re-examined and fulminated, in the general council of Chalcedon, in 451. The legates of pope Leo, who assisted at it, maintained, that it was not enough to define, that there were two natures in Jesus Christ, but insisted strenuously, that, to remove all equivocations, they must add these terms, *without being changed, or confounded, or divided*.

The heresy of the Eutychians, which made a very great progress throughout the East, at length became divided into several branches. Nicephorus makes mention of no fewer than twelve; some called *schematici*, or *apparentes*, as only attributing to Jesus Christ, a phantom, or appearance of flesh; and no real flesh; others *Theodosians*, from Theodosius, bishop of Alexandria; others *Jacobites*, from one James, *Jacobus*, of Syria; which branch established itself principally in Armenia, where it still subsists. Others were called *Acephali*, q. d. *without head*; and *Severians*, from a monk called Severus, who seized on the see of Antioch in 513.

These last were subdivided into five factions, *viz. Ag-*

*noete*, who attributed some ignorance to Jesus Christ; the followers of Paul; *Μελανοι*, that is, the *black Angelites*, thus called from the place where they were assembled; lastly, *Adrites*, and *Cononites*.

EUTYCHIANS was also the name of another sect, half Arian, half Eunomian, which arose at Constantinople in the fourth century.

It being then a matter of mighty controversy among the Eunomians at Constantinople, whether or no the Son of God knew the last day and hour of the world, particularly with regard to that passage in the Gospel of St. Matthew, chap. xxiv. ver. 36. or, rather, that in St. Mark, xiii. 32. where it is expressed, that *the Son did not know it, but the Father only*; Eutychius made no scruple to maintain, even in writing, that the Son did not know it; which sentiment displeasing the leaders of the Eunomian party, he separated from them, and made a journey to Eunomius, who was then in exile.

That heretic acquiesced fully in Eutychius's doctrine, and admitted him to his communion; Eunomius dying soon after, the chief of the Eunomians at Constantinople refused to admit Eutychius; who, upon this, formed a particular sect of such as adhered to him, called *Eutychians*.

This same Eutychius, and one Theophronius, as was said in Sozomen's time, were the occasions of all the changes made by the Eunomians in the administration of baptism; which consisted, according to Nicephorus, in only using one immersion, and not doing it in the name of the Trinity, but in memory of the death of Jesus Christ.

Nicephorus calls the chief of that sect not Eutychius, but Eupychius, and his followers Eunomioeupychians.

EUTYCHIANUS, in *Biography*, bishop of Rome, succeeded to that high office on the death of Felix, in the year 275, and presided over the church about eight or nine years, when he died. Catholics have considered him as a martyr to the cause of truth; but historians, in general, infer, from the unmolested state of Christians, at that period, in Rome, that he died a natural death. There are two decretal epistles of this pope extant, relative to subjects of ecclesiastical discipline. Moreri. Bower.

EUTYCHIUS, patriarch of Constantinople, was born in the year 512. He was brought up to the ecclesiastical profession, and obtained in early life the episcopal dignity in a town of Pontus, which he afterwards relinquished, and entered into a monastery in the city of Amasæa. In 552 he was deputed by the bishop of that city to Constantinople, as his representative, in the approaching general council that was to be held there. Before the meeting of the council, he obtained the favour of Justinian, who raised him to the patriarchate of Constantinople, which became vacant in the year 553, by the death of Mennas. Almost immediately after he had assumed the new character, he presided at the council in which the opinions of Origen and his followers were condemned. Some years after, *viz.* in the year 564, Justinian endeavoured to obtain the patriarch's sanction to a doctrine which he had adopted, *viz.* that the body of Jesus Christ was rendered incorruptible before his resurrection, by the union of the divine and human natures; but when Eutychius steadily refused to countenance the opinion, the emperor deposed him from the patriarchate and sent him into exile. In 578, he was reinstated in the see of Constantinople, by the emperor Tiberius II. and he died in the year 585, at the age of 73. There is extant, in the fifth volume of the "Collectio Conciliorum," an epistle of his to pope Vigilius.

He was author of other pieces; of these a fragment of one only remains, "Concerning the Souls of the Dead." Moreri.

**EUXINE SEA**, called the *Black Sea*, as it is said, either from its black rocks, or dangerous navigation, an inland sea, situated partly in Europe, and partly in Asia; bounded on the north by the government of Caucasus and Ekatarinoflav, on the east by Mingrelia and Georgia, on the south by Natolia, and on the west by European Turkey. This sea is divided into the Euxine proper, the Pontus Euxinus, computed to be 1000 versts in length, and 500 in breadth, and the sea of Azof, (see Azof) the Palus Mæotides of the ancients, which, without including the bay of Taganroh, is stated to be 200 versts long, and 160 versts broad. Both these are now entirely within the confines of the Russian empire. The sea of Azof, called palus, or a marsh, by the ancients, because it was polluted by mud, is united to the Euxine by the straits of Caffa, or the ancient Cimmerian Bosphorus. The most important of the bays formed by these seas are the Liman, at the mouth of the Dnieper, the bay near Perekop, and that close to Yenikalé. The most considerable island belonging to these seas in the vicinity of the Russian coasts, is Taman. The principal harbours are Caffa, now Theodosia, Sebastopol, Kofkof, Balaklava, and some others. At the western extremity of these seas, within the province of Taurida, is a very large pool, called Sivash, or the Putrid sea, which is about 140 versts long, and 54 broad. The chief rivers that fall into the Euxine, are the Kuban, or Hypanis of the ancients, the Don, or ancient Tanais, the Dnieper or Borysthenes of ancient geographers, and the Bogur, which rises in Poland, parting that kingdom, and a portion of European Turkey from Russia, and at Otchakof, falls into the Euxine. The Euxine sea was formerly denominated ἀξινος, or *inhospitable*, on account of the barbarity of the inhabitants of its coasts; but when they became civilized by their commerce with the Greeks, the name was changed into ευξινος, i. e. *hospitable*, or favourable to strangers.

**EUZET**, a town of France, in the department of the Gard; nine miles W. N. W. of Uzès.

**EUZOIUS**, in *Biography*, was in early life a deacon of the church of Alexandria, from which office he was expelled by Alexander, bishop of that see, at the same time with Arius, on account of his espousing the principles of that celebrated character. They were both involved in the like condemnation at the council of Nice. About the year 355, he presented a confession of faith to the emperor Constantine, which met with the approbation of that sovereign, and which was the means of bringing him into consequence at the imperial court, when the orthodox party were thrown in the back ground. He was appointed to the see of Antioch, and called upon to baptize the emperor Constantius. His influence was now very considerable, and to this the friends of Athanasius attribute much of the persecution by which that bishop was harassed. Moreri.

**EUZOIUS**, bishop of Cæsarea, was educated in that city at the same time with Gregory Nazianzen. On the death of Acacius he obtained the bishopric of Cæsarea, after maintaining a violent contest with the different rival candidates. He was in principle an Arian, or nearly so, and on that account was deposed from his see under the reign of the emperor Theodosius, about the year 380. He was author of numerous treatises now lost; possessed with much learning, and was very diligent in the discharge of his episcopal functions; but he is principally celebrated on

account of his great exertions in promoting the interests of science and literature. He manifested much zeal in the restoration and improvement of the library at Cæsarea, which had been originally collected by Origen and Pamphilus, and was at this period fallen into decay. To this object he devoted his time and labour, taking care that faithful transcripts should be procured of such books as were in a perishing state, and increasing their numbers by new collections. Moreri.

**EWAGE**, *Ewagium*, in our *Old Writers*, the same with *aquage*, which is toll paid for water-passage. It is derived from the French *eau*, water.

**EWALD**, JOHN, in *Biography*, a Danish poet, was born at Copenhagen in the year 1743. His father was a clergyman, and when he found his own end approaching he sent his son for education to Sleswick, and died in a few hours after. Licht, the person to whose care young Ewald was entrusted, treated him in every respect as his own son, and gave him free access to his library. The books most agreeable to his taste were romances, which he read with the greatest avidity. The adventures of Tom Jones and Robinson Crusoe, particularly the latter, had made such an impression on his mind, and had excited his passions so strongly, that he eloped from Sleswick in his thirteenth year, in order to proceed to Holland, that he might undertake a voyage to Batavia, in the hope of being shipwrecked and thrown on some desert island. Scarcely had he travelled four miles, before he was overtaken by his preceptor and friend, who carried him back by force. At another time having read and heard of many romantic tales respecting saints and martyrs, he was desirous of becoming a martyr for the cause of Christianity. At length he resolved upon the profession of a soldier, which being opposed by his friends, he left home, in company with his brother, and joined the Prussian service, from this he deserted to the Austrian army, in which he was first a drummer, and then a serjeant. A commission was offered him, provided he would embrace the Catholic religion, which he absolutely refused, and in a short time deserted again. On his return to Denmark he devoted himself to theology, and studied with so much diligence as to be fit for examination in the course of a year. He had paid his addresses to a lady, who, suspecting him not to be in earnest, gave her hand to another: this to affected Ewald as to produce a complete change in his disposition, and to give his ideas a melancholy cast. He now abandoned himself to pleasure, and injured his constitution. To give vent to the effusions of his mind, he wrote a piece, called "The Temple of Good Fortune," which proved the source of all his future fame. It obtained the approbation of the society of Belles-lettres; and procured him the friendship of M. Carlens, a zealous votary of the muses, which he enjoyed, without interruption, during the remainder of his life. On the death of Frederic V. in 1766, he composed an elegy, which was received with universal approbation, and Ewald, intoxicated with the praises bestowed upon his work, began to consider himself one of the greatest poets that Denmark had ever produced. The society of Belles-lettres proposed as the subject of a prize the best ode on any of the attributes of the deity, and Ewald, determined to try his fortune, made choice of the divine goodness, and had already formed his plan, when he learned that Benzon, one of his most intimate friends, was employed on the same subject. Unwilling to enter the contest with a friend he abandoned his subject, and wrote his Adam and Eve, a sort of half drama, in one act, which possessed much merit, but without order or any regard to the laws of composition. He hoped that this might obtain the prize, but was disappointed, and began to study poetry, being now resolved to read; and

not to write any more for two years. The works of Corneille and Klopstock fell into his hands, and gave his taste a new direction. His next work was "Rolfé Krage," a tragedy in the style of Ossian, and "The songs of Skalden," which he wrote under the eye of Klopstock, who had a very great and sincere affection for him. During the time he was employed on this piece, he was attacked by a disease, under which he languished for ten years. It proceeded from the gout, and was often attended with excruciating pain, yet his spirits and cheerfulness rarely forsook him, and he wrote in the intervals of his ease some small theatrical pieces, which in part related to present times and manners, and which abounded with humour and the keenest satire. Ewald had obtained from the king a pension of a hundred dollars, but this being insufficient for his maintenance, he was obliged, by writing temporary poems, to gain a part of his livelihood, till the profits arising from the representation of his theatrical pieces, and from the sale of his works, should place him beyond the fear of want. He died at Copenhagen in March 1781, in the thirty-eighth year of his age. In strength of imagination, spirit and originality, Ewald surpasses all the other Danish poets. His excellent qualities gained him the affection of those who knew him. He never prostituted his muse to improper purposes, and never, says his biographer, did an immoral or pernicious line flow from his pen. A complete edition of his works was published at Copenhagen between the year 1781—1791. Gen. Biog.

EWANICZOW, in *Geography*, a town of Poland, in the palatinate of Kaminiéc; 64 miles N.N.W. of Kaminiéc.

EWANO, a town of Poland, in Galicia; 36 miles S.E. of Halicz.

EWE, a small island on the W. coast of Scotland, at the entrance of Loch Ewe. N. lat.  $57^{\circ} 53'$ . W. long.  $5^{\circ} 37'$ .

EWE, in *Rural Economy*, the female of the sheep kind of animals. It is of very great importance in the forming of this sort of stock to have good ewes. (See SHEEP.) It is the practice in some of the more northern districts to have recourse to the milking of the ewes in order to make cheese from it. But it is said to have been lately found so injurious to the animals, and to be attended with so little profit, that it is, at present, much on the decline.

EWE-Cheese, is that sort of cheese which is prepared from the milk of the ewe. It is a very strong pungent kind of cheese, which is not well relished by many. Some, however, consider it as very rich and excellent, preferring it to the other sorts of cheese. In some places these cheeses are made of a considerable size, perhaps, nearly as large as those of the Cheshire dairies, one, two, or three hundred ewes being milked regularly for the purpose. See CHEESE.

EWELL, in *Geography*, is a market town in the hundred of Copthorne, and county of Surry, situated at the foot of Banstead downs, distant S.E. by E. of London 13 miles. The weekly market is held on Thursdays, and it has two annual fairs, one the 12th of May, the other the 29th of October. The number of houses, according to the returns in 1801, is 194, and of inhabitants 1112. Here is the head of an extraordinary spring, which forms a curious natural jet d'eau, breaking out in several places. After watering Epfom-court meadows it flows in a fine stream called the Malden, and falls into the river Thames at Kingston.

Near this town stood the magnificent palace, from its grandeur and splendid decorations, denominated "None-Such," erected by king Henry the Eighth. Charles the Second having conferred it upon his favourite mistress, the infamous duchess of Cleveland, she caused it to be taken down, and sold the materials.

EWENNY, a river which has its source in the mountains to the north of Peterston super montem, and passing by Coychurch and Eweny priory, joins the river Ogmoré near Merthyr Mawr, below which it falls into the Bristol channel. A phenomenon on this stream has given rise to a geological error, which has generally been credited with ut proper investigation, that the river makes a "dip under a mountain, appearing again near Nevera bridge, after a subterraneous passage of two miles." "Mr. Lethieuller observes, "that between Merthyr Mawr, near which also were deep sands, and New-inn bridge, the river Ogmoré, or rather a branch of it, runs a quarter of a mile under the hill, passing also under several natural bridges; after which, issuing out with great violence, it joins the main stream. The maps again here mistake in giving this river the name of Ogmoré before its junction with the Eweny, after which only it assumes that name, being called before the Bridgend river, as it comes from Bridgend, where it runs under ground a little to the north of that place, and appears again from under Ogmoré hill." See *Archæologia*, vol. iv. p. 27. It occurs near the junction of the Eweny with the river Ogmoré. From the foot of a long ridge of down, where the hill makes a bold escarpement to the vale, issues a large body of water, exceeding the quantity previously flowing down the river, except after rains. In its passage from under the hill it is heard to boil and rage, and rushes out with foaming impetuosity, as though it had met with violent interruption in its course; and forms two streams, which immediately appear different in the velocity of their motions and quality of their contents; one being what is vulgarly called *hard*, and the other *soft* water. The stream to the southward is sought for culinary, and that to the northward for lavatory purposes. In trying it, Mr. Evans observes, "the water from the opposite sides of the stream had a different effect upon the tongue and palate, and by a brief analysis it was discovered, that the one contained a portion of calcareous matter in solution; and the other left but little residue, which was of an argillaceous nature." An attempt was then made to ascertain whether the river might not enter some other part of the hill, and by a subterraneous passage here seek daylight again, as is reported of the Deveril in Wiltshire, and the Mole in Surry. But after a fruitless search the smallest vestige of such a subterraneous course could not be traced. The phenomenon therefore in question appears to proceed from two powerful springs, rising in the internal parts of the hill, the streams of which having flowed separately, here unite, but without intermingling their waters, till they join the Eweny. Evans's Tour in South Wales.

EWENNY Priory, in *Antiquity*, was a monastery of the Benedictine order, founded by John Maurice de Lumbres, Lord of Ogmoré, A. D. 1140; and given as a cell to Gloucester Abbey. Its revenues, as valued at the dissolution, were 78*l.* 0*s.* 8*d.* It stands close to the road leading from Newton to Pyle in Glamorganshire, South Wales, in a marshy plain, near the banks of the river Eweny. It was surrounded by strong embattled walls, having two gateways; and the one forming the principal entrance had two portcullises: these, with parts of massive towers visible among its ruins, indicate it was intended as a place of security, as well as religious retirement. The buildings appear to have been very extensive, and some rooms, which formed the abbót's lodge yet remaining, are large and stately; particularly the great hall or refectory. But the abbey church, still standing, is a noble edifice, the simple and uniform architecture of which must be gratifying to every admirer of the arts. It is a massive building of a cruciform shape, consist-

ing of a nave, two transepts, and a choir; in which heavy circular arches rest upon round bulky columns with simple capitals: the windows also and door-ways have all the circular arch, which have induced some to refer it to a Saxon period. The whole certainly denotes the earliest Norman style of architecture. The curious stone vaulted groined roof of the choir claims particular attention; and the neglected effigies of the founder, bearing this inscription, "Ici gist Morice de Lundres le fundur, Deu li rende sun labur. Am." In the south transept lies another rude stone figure of a knight in armour, which has generally been thought commemorative of Pain de Tuberville lord of Coity. But sir Richard Hoare has shewn this statement, which originated with Camden, to be erroneous. After having the tomb cleaned, he was enabled to read the inscription thus,

"Sire Roger de Remi gist ici  
Deu de son alme eit merci am."

The person here named "De Remi," sir Richard supposes to have been some friend, and follower of Morice de Lundres. The floor of the church has been paved with glazed porcelain tiles, ornamented with various devices, such as are seen in other buildings of a similar nature; but few now remain. The nave is at present used as the parish church for divine worship, and the choir has a cemetery for distinguished families in the vicinity: monuments for whom, particularly that of Carne, adorn its walls. It must be matter of regret to those interested in ancient buildings, to see the present dilapidated state of this once noble structure: in many places roofless, the windows unglazed, the roof of the choir cracked, the sepulchral monuments broken, and thrown carelessly about; and this noble sanctuary, which has stood near seven hundred years, and exhibits the most perfect specimen of early Norman architecture of any church in the kingdom, rapidly approaching to its dissolution. Evans's Tour in South Wales, and the Translation of Gyraldus's Itinerarium by sir Richard Colt Hoare.

EWER, in *Rural Economy*, a term sometimes provincially applied to the udder of the cow, or other animal. See UDDER.

EWES, or EUS, in *Geography*, a river of Scotland, which joins the Esk at Langholm, in Dumfries-shire; and the valley through which it passes is called Ewesdale.

EWRY, an office in the king's household, where they take care of the linen for the king's table; lay the cloth, and serve up water in silver ewers after dinner, whence the office takes its name.

EXACERBATION, in *Medicine*, signifies the increase or return of the symptoms in those fevers of the remittent, intermittent, or even continued class, in which the febrile condition is renewed at regular periods, or becomes augmented. It is nearly synonymous with *Paroxysm*; but is more particularly restricted to the periodical increase of the remittent, or continued fevers, in which there is no absolute cessation of the febrile state. The evening exacerbation of hectic fever is a familiar example. Dr. Cullen asserts his belief, that there are commonly two exacerbations and remissions both of hectic and of continued fever in the day; the one in the forenoon, the other in the evening: that of the morning, however, if it really occurs, is less distinct, and many practitioners have been unable to detect it. See FEVER, and HECTIC.

EXACHORD. See HEXACHORD.

EXACHORDE, *Fr.* ESSACORDO, *Ital.*, an instrument with six strings, or a system composed of six sounds, such as the hexachord of Guido, which see.

EXACTION, in *Law*, a wrong done by an officer, or

one pretending to have authority: in taking a reward, or fee, for that in which the law allows not of any.

The difference between exaction and extortion, consists in this; that extortion is, where the officer takes more than his due; and exaction, where he wrests a fee, or reward, where none is due.

EXACTIS, in *Natural History*, a name given by Linnæus, and some other authors, to a species of star-fish, of the more branched kind, whose rays are six in number, when they first part from the body, but very soon branch out into a great number more. See STAR-fish.

EXACTOR REGIS, in *Law*, the king's exactor, or collector. Sometimes it is taken for the sheriff. But generally, "quicumque publicas pecunias, tributa, vestigalia & res fisco debitas exigit, proprie nominatur exactor regis."

EXACUM, in *Botany*, a name which Pliny says has been given to the Lesser Centaury, because it carries off all bad medicines by stool, apparently from *εξ*, out of, and *ακρωτα*, to drive, or force onward. Linn. Gen. 57. Schreb. 77. Willd. Sp. Pl. v. 1. 634. Sm. Fl. Brit. 182. Mart. Mill. Dict. v. 2. Juss. 142. Gærtn. t. 114. Class and order, *Tetrandria Monogynia*. Nat. Ord. *Rutaceæ*, Linn. *Gentiana*, Juss.

Gen. Ch. Cal. Perianth inferior, in four deep, ovate, slightly spreading, permanent segments. Cor. of one petal, permanent, salver-shaped; tube inflated, the length of the calyx; limb in four deep, roundish, spreading lobes. Stam. Filaments four, thread-shaped, inserted into the tube, not so long as the limb; anthers roundish. Pist. Germen superior, oval, filling the tube; style thread-shaped, rather oblique, the length of the stamens; stigma capitate. Peric. Capsule elliptical, as long as the calyx, compressed, with a longitudinal furrow at each side, of two cells, bursting at the top. Seeds numerous, small, roundish, affixed to a central receptacle which forms the partition of the capsule.

Ess. Ch. Calyx in four segments. Corolla salver-shaped, with an inflated tube. Capsule superior, with two furrows, two cells, and many seeds, bursting at the top. Stigma capitate.

Obs. The flowers in some species are five-cleft, with a correspondent number of stamens.

Since this genus was founded by Linnæus on the examination of some dried East Indian specimens of his *E. sessile* and *pedunculatum*, Sp. Pl. 163, several species have been added to it by different botanists, either entire new discoveries, or separated from the old genus of *Gentiana*. Vahl has also referred hither the *Coutoubeæ* of Aublet, Guian. t. 27, 28, with unquestionable propriety, though Jussieu and Schreber have kept it separate, the latter by the name of *Picrium*, alluding to its bitterness.

Our only British species is *E. filiforme*, Engl. Bot. t. 235, found in spongy or sandy bogs, in Dorsetshire, Devonshire; and Cornwall, flowering in July. This is a small, slender, inconspicuous annual, with a branched stem; opposite, sessile, lanceolate leaves; and small, terminal, solitary, yellow flowers, expanded only while the sun shines bright upon them. It was the *Gentiana filiformis* of Linnæus and all following authors, till referred to *Exacum* in Engl. Bot.

*E. viscosum*. Sm. Ic. Pi&t. t. 18. (*Gentiana viscosa*; Ait. Hort. Kew. v. 1. 321.) has pentandrous five-cleft flowers. This is a handsome green-house plant, brought from the Canary islands by Mr. Masson. The stem is shrubby, three feet high, with oblong ribbed leaves, and large terminal panicles of yellow flowers.

The annual species are scarcely to be cultivated, no succulent

cessful method of raising them from seed in a garden having yet been discovered.

**EXÆRESIS**, from *εξ*, *out of*, and *αιρειναι*, *to remove*, in *Surgery*, was divided by the ancients into six branches, namely, lynchæsis, diæresis, exæresis, apheræsis, prosthesis, and diorthrosis. Exæresis implied all such methods and operations, as had for their object the removal of diseased, redundant, or extraneous substances from the body.

**EXAGGERATION**, in *Rhetoric*, a figure whereby we enlarge or heighten things; making them appear more than they really are, whether as to goodness, badness, or other qualities.

The word is formed of the Latin *exaggero*, *I exaggerate*; which is a compound of *ex* and *agger*, *a mound*, or *elevation of earth*. See **HYPERBOLE**.

**EXAGGERATION**, in *Painting*, is a method of representing things, wherein they are loaded too much, or marked too strongly; whether in respect of the design, or the colouring, or the position of the object.

Exaggerating differs from caricaturing, in that the latter perverts, or gives a turn to the features, &c. of a face which they had not; whereas the former only improves, or heightens what they had.

The latter is a kind of burlesque on the object, and is generally meant to ridicule: the former is usually an exalting or enlivening of the beauties of the object, beyond what nature allows. The painter is obliged to have recourse to an exaggeration of colours, both on account of the surface of his ground, the distance of his work, and of time, and the air, which diminish and weaken the force of the colours; but this exaggeration must be conducted in such a manner, as not to put the objects out of their natural characters. The term exaggeration is not now in use. See **STYLE** in *Painting*.

**EXAGON**. See **HEXAGON**.

**EXALMA**, from *εξαλλω*, *to leap out*, in *Surgery*, a dislocation of the vertebrae, according to Hippocrates.

**EXALTACION**, in *Geography*, a town of South America, in the government of Moyes; 50 miles S. of Trinidad.

**EXALTATION of the Cross**. See **Exaltation of the Cross**.

**EXALTATION**, **ELEVATION**, is chiefly used in a figurative sense, for the raising or advancing a person to some ecclesiastical dignity; and particularly to the papacy.

The term exaltation is, in some measure, appropriated to the pope; and expresses his inauguration, coronation, taking possession, and the beginning of his pontificate.

We shall here add, that the cross was delivered up by a treaty of peace made with Siroes, Chosroes' son. The institution of this treaty is commonly said to have been signalized by a miracle; in that Heraclius could not stir out of Jerusalem with the cross, while he had the imperial vestments on, enriched with gold, and precious stones; but bore it with ease, in a common dress.

But, long before the empire of Heraclius, there had been a feast of the same denomination observed both in the Greek and Latin churches, on occasion of what our Saviour said in St. John, xii. 32. "And I, if I be exalted, or lifted up, will draw all men unto me." And again, in ch. viii. ver. 28. "When ye have exalted, or lifted up, the Son of man, then shall ye know that I am he." F. Du Soulier assures us, that M. Chastelain was of opinion, this feast had been instituted, at least at Jerusalem, two hundred and forty years before Heraclius.

The feast of the dedication of the temple built by Constantine, was held, says Nicephorus, on the fourteenth of September, the day on which the temple had been consecrated,

in the year 335; and this feast was also called the exaltation of the cross, because it was a ceremony therein, for the bishop of Jerusalem to ascend a high place, built by Constantine for that purpose, in manner of a pulpit, called by the Greeks, the "sacred mysteries of God," or, "the holiness of God," and there hoist up the cross, for all the people to see it.

**EXALTATION**, in *Physics*, denotes the act, or operation, of elevating, purifying, subtilizing, or perfecting, any natural body, its principles and parts; also the quality, or disposition, which bodies acquire by such operation.

The term exaltation has been peculiarly affected by the ancient chemists and alchemists; who imagining it to have some extraordinary emphasis, are employing it on every occasion.

**EXALTATION**, in *Astrology*, is a dignity which a planet acquires in certain signs, or parts of the zodiac; which dignity is supposed to give it an extraordinary virtue, efficacy, and influence. The opposite sign, or part of the zodiac, is called the dejection of the planet.

Thus, the 15th degree of Cancer is the exaltation of Jupiter, according to Albumazar, because it was the ascendant of that planet at the time of the creation; that of the sun is in the 19th degree of Aries; and its dejection in Libra; that of the moon is in Taurus, &c. Ptolemy gives the reason of this in his first book *De Quadrup.*

**EXAMEN**, or **EXAMINATION**, an exact and careful search, or inquiry, in order to discover the truth or falsehood of a thing.

**EXAMILION**, &c. See **HEXAMILION**, &c.

**EXAMINATION**, **SELF**, is a point much insisted on by divines, and particularly the ancient fathers, by way of preparation to repentance. St. Ignatius reduces it to five points; *viz.* 1. A returning of thanks to God for his benefits. 2. A begging of grace and light, to know and distinguish our sins. 3. A running over all our actions, occupations, thoughts, and words, in order to learn what has been offensive to God. 4. A begging of pardon, and conceiving a sincere sorrow for having displeased him. And, 5. Making a firm resolution not to offend him any more; and taking the necessary precautions to preserve ourselves from it.

**EXAMINATION of Bankrupt**, in *Law*. See **BANKRUPT**.

**EXAMINATION of Prisoners**. See **COMMITMENT**.

**EXAMINATION**, or **INSPECTION**, *Trial by*, is when, for the greater expedition of a cause, in some point or issue being either the principal question, or arising collaterally out of it, but being evidently the object of sense, the judges of the court, upon the testimony of their own senses, shall decide the point in dispute. Thus, in case of a suit to reverse a fine for non-age of the cognizor, or to set aside a statute or recognizance entered into by an infant; in this, and in similar cases, a writ shall issue to the sheriff (9 Rep. 31.), commanding him that he constrain the said party to appear, that it may be ascertained by the view of his body by the king's justices, whether he be of full age or not. If, however, the court, upon inspection, has any doubt of the age of the party, it may proceed to take proofs of the fact; and, particularly, may examine the infant himself upon an oath of *voir dire*, *veritatem dicere*, that is, to make true answer to such questions as the court shall demand of him; or the court may examine his mother, his godfather, or the like. (2 Roll. Abr. 573.) In like manner, if a defendant pleads in abatement of the suit that the plaintiff is dead, and one appears and calls himself the plaintiff, which the defendant denies; in this case the judges shall deter-

mine, by inspection and examination, whether he be the plaintiff or not. (9 Rep. 30.) Also, if a man be found by a jury an idiot, *à nativitate*, he may come in person into the chancery before the chancellor, or be brought there by his friends, to be inspected and examined, whether idiot or not; and if, upon such view and inquiry, it appears he is not so, the verdict of the jury, and all the proceedings thereon, are utterly void and instantly of no effect. (Ibid. 31.) The trial by inspection may be also used, upon an appeal of *maihem*, when the issue joined is whether it be *maihem* or no *maihem*, this shall be decided by the court upon inspection, for which purpose they may call in the assistance of surgeons. (2 Roll. Abr. 578.) And by analogy to this, in an action of trespass for *maihem*, the court (upon view of such *maihem* as the plaintiff has laid in his declaration, or which is certified by the judges who tried the cause to be the same as was given in evidence to the jury) may increase the damages at their own discretion (1 Sid. 108.); as may also be the case upon view of an atrocious battery. (Hardr. 408.) But then the battery must likewise be alleged so certainly in the declaration, that it may appear to be the same with the battery inspected. Also, to ascertain any circumstances relative to a particular day past, it hath been tried by an inspection of the almanac by the court. Thus, upon a writ of error from an inferior court, that of Lynn, the error assigned was that the judgment given was on a Sunday, it appearing to be on the 26th February, 26 Eliz. and upon inspection of the almanacs of that year, it was found that the 26th of February in that year actually fell upon a Sunday: this was held to be a sufficient trial, and that a trial by a jury was not necessary, although it was an error in fact, and so the judgment was reversed. (Cro. Eliz. 227.) But, in all these cases, the judges, if they conceive a doubt, may order it to be tried by a jury. Blackst. Com. vol. iii.

EXAMINATION of witnesses, in the trial by jury, derives peculiar advantage from its being conducted openly, *vivâ voce*, in the presence of all mankind. This mode of examination is much more conducive to the clearing up of truth, than the private and secret examination taken down in writing before an officer or his clerk, in the ecclesiastical courts, and all others that have borrowed their practice from the civil law, where a witness may frequently depose that in private, which he will be ashamed to testify in a public and solemn tribunal. Besides, the occasional questions of the judge, the jury, and the counsel, propounded to the witnesses on a sudden, will sift out the truth much better than a formal set of interrogatories previously penned and settled; and the confronting of adverse witnesses is also another opportunity of obtaining a clear discovery, which can never be had upon any other method of trial. Nor is the presence of the judge, during the examination, a matter of small importance; for, besides the respect and awe with which his presence will naturally inspire the witness, he is able by use and experience to keep the evidence from wandering from the point in issue. In short, by this method of examination, and this only, the persons who are to decide upon the evidence have an opportunity of observing the quality, age, education, understanding, behaviour, and inclination of the witnesses; in which points all persons must appear alike, when their depositions are reduced to writing, and read to the judge, in the absence of those who made them; and yet as much may be frequently collected from the manner in which the evidence is delivered as from the matter of it. See EVIDENCE.

EXAMINATION of witnesses in Chancery is done with a view to the proof of facts that are disputed, and their de-

positions are taken in writing, according to the manner of the civil law. For this purpose interrogatories are formed or questions in writing; which, and which only, are to be proposed to, and asked of, the witnesses in the cause. For the examination of witnesses in or near London, there is an examiner's office appointed; but for such as live in the country, a commission is granted to four commissioners, two named on each side, or any three or two of them, to take the depositions there. And if the witnesses reside beyond seas, a commission may be had to examine them there upon their own oaths, and (if foreigners) upon the oaths of skilful interpreters. And it hath been established that the deposition of an heathen who believes in the Supreme Being, taken by commission in the most solemn manner according to the custom of his own country, may be read in evidence. The commissioners are sworn to take the examinations truly and without partiality, and not to divulge them till published in the court of chancery; and their clerks are also sworn to secrecy. The witnesses are compellable by process of *sub-pœna*, as in the courts of common law, to appear and submit to examination. And when their depositions are taken, they are transmitted to the court with the same care that the answer of a defendant is sent. See COMMISSION to examine witnesses, and INTERROGATORIES.

EXAMINERS, in Chancery, are two officers, whose business is to examine, on oath, the witnesses produced on both sides, upon such interrogatories as the parties to the suit do exhibit for the purpose.

EXAMPLE, in Rhetoric, denotes an imperfect kind of induction or argumentation; whereby it is proved, that a thing which has happened on some other occasion, will happen again, on the present one, from the similitude of the cases. That is usually called an example, which is brought either to prove or illustrate some general assertion, as if one should say, that "human bodies may be brought to sustain the greatest labours by use and exercise;" and in order to prove this should relate what is said of Milo of Croton, that "by the constant practice of carrying a calf several furlongs every day, he should carry it as far after it was grown to its full size." (Erasm. Chil. p. 193.) But the word example is used in oratory for any kind of similitude; or, as Vossius defines it (Orat. Partit. l. iii. c. 7. § 16.), "When one thing is inferred from another, by reason of the likeness which appears between them." Hence it is called an "imperfect induction," which infers something from several others of a like nature. With regard to examples, we may observe, that those have the greatest force in reasoning, which are taken from facts. See INDUCTION.

EXANIA, from *ex*, out of, and *anus*, the complaint now more commonly named by practitioners in surgery prolapsus ani. See PROLAPSUS.

EXANNUAL ROLL. In the old way of exhibiting sheriff's accounts, the illeivable fines and desperate debts were transcribed into a roll, under this name, which was yearly read, to see what might be gotten by it.

EXANTHEMA, in Medicine, synonymous with *efflorescence*, from *εξ*, and *αἶμα*, a flower, a term applied by the older writers nearly in the same sense in which we now employ the word *eruption*, and comprehending every species of spot, discolouration, or elevation of the skin. The systematic nosologists at present understand by this word all eruptions on the skin, which are accompanied with fever; such as the small-pox, measles, scarlet fever, &c. Dr. Willan uses the term in a more limited sense, *viz.* to express that appearance only which is in English denominated a *rash*; which is a blush or "redness of the skin, varying as to extent, continuity, and brightness of colour, and occasioned

by an unusual quantity of blood distributed to several of the cutaneous veins, in some instances with partial extravasation." The exanthemata constitute the third order of Dr. Willan's classification of cutaneous diseases, including the measles, scarlet fever, nettle-rash, roseola, purpura, and erythema. See *CUTANEOUS diseases*, and these words respectively. See also Cullen Nosol. Method. class. i. order iii. Willan on Cutan. Dif. ord. iii.

EXARCH, *Ἐξαρχος*, in *Antiquity*, an appellation given, by the emperors of the East, to certain officers sent into Italy, in quality of vicars, or rather prefects, to defend that part of Italy which was yet under their obedience; particularly the city of Ravenna, against the Lombards, who had made themselves masters of the greatest part of the rest.

The residence of the exarch was at Ravenna; which city, with that of Rome, were all that was left to the emperors. The first exarch was Longinus, who was sent in the year 568 by the emperor Justin II. the successor of Justinian, to govern Italy in the room of Narfes. Longinus, being invested with absolute authority and power, suppressed the magistrates, who had been previously appointed to govern the provinces of Italy; and he himself took the title of exarch, which by the Greeks was given to those who presided over a diocese, and consequently over the numerous provinces of which the diocese was composed. This title was adopted by the successors of Longinus, who, residing, as he had done, at Ravenna, were on that account called the exarchs of Ravenna. They governed all Italy, naming and removing the magistrates, called dukes, at their pleasure; and to them the people had recourse in all matters of consequence. Longinus was sent by Justin to rule all Italy; but a great part of that country, in the first year of his government, was seized on by the Lombards, who had been called in by Narfes. This magistrate maintained the power and authority of the emperors of the East in Italy for the space of 183 years, that is, from the year 568, when Longinus was sent into Italy, to the year 751, when Eutychius, the last exarch, was expelled, and Ravenna taken by Astulphus, or Astolphus, king of the Lombards. See **LOMBARDS**.

According to Gibbon (*Decline and Fall of the Roman Empire*, vol. vii.) Narfes was the first and most powerful of the exarchs, and administered above fifteen years the kingdom of Italy. A duke was stationed for the defence and military command of each of the principal cities of Italy; and the eye of Narfes pervaded the ample prospect from Calabria to the Alps. During a period of 200 years, says the historian, (vol. viii.) Italy was unequally divided between the kingdom of the Lombards and the exarchate of Ravenna; and 12 successive exarchs were invested, in the decline of the empire, with the full remains of civil, of military, and even of ecclesiastical power. Their immediate jurisdiction, which was afterwards consecrated as the patrimony of St. Peter, extended over the modern Romagna, the marshes or valleys of Ferrara and Commachio, five maritime cities from Rimini to Ancona, and a second, inland Pentapolis, between the Adriatic coast and the hills of the Apennines. Three subordinate provinces, of Rome, of Venice, and of Naples, which were separated by hostile lands from the palace of Ravenna, acknowledged, both in peace and war, the supremacy of the exarch. The remainder of Italy was possessed by the Lombards. When Astulphus, as we have already mentioned, had made himself master of the exarchate, he thought that he had a just title to all the places depending on that domain, and consequently to the Roman dukedom and to Rome itself. He, therefore, required by a mes-

ger the inhabitants of that city to acknowledge him for their sovereign; and at the same time began his march towards Rome. The pope, Stephen II., was alarmed, and attempted to divert Astulphus from his declared purpose of plundering Rome and massacring the inhabitants, by a solemn embassy; but the king, rejecting the presents accompanying this embassy, insisted upon being acknowledged by the pope and the Romans for their sovereign. The pope in this distress applies to the emperor; but Constantine was not in a condition to assist him. He then determined to recur to the protection of France, which had been transferred, some years before, from the Merovingian to the Carolingian line; and the celebrated Pepin, son to Charles Martel, was then king. Indeed Pepin had previously promised to pope Zachary, that he would protect his see against all its enemies, especially against the Lombards. Pope Stephen visited France in person; and having stated the deplorable condition to which he was reduced by the Lombards, and implored his assistance and protection, Pepin promised to assist him against the Lombards with the whole strength of his kingdom, and to drive them out of the exarchate and Pentapolis, which were to be restored, as Pepin understood, to the emperor, from whom the Lombards had taken them; but the pope, finding the king well-disposed, took advantage of this favourable opportunity for aggrandizing himself; and, therefore, insinuated to Pepin, that he could not better acquit himself of his obligations to the apostolic see, consult the welfare of his soul, or reward him for the dangers he had undergone, and the pains he had taken for the safety of Italy, and the church, than by granting both the exarchate and Pentapolis to St. Peter, that is, to himself. The pope, at the same time, pretended that Constantine had forfeited all right to those countries, by forsaking the protection of Italy, and persecuting the church. Pepin not only put him in possession of the exarchate and Pentapolis, if he should succeed in expelling the Lombards, but confirmed his promise with an oath, in which his sons Charles and Carloman concurred. In consequence of this engagement Pepin marched with his army against the Lombards, and having routed them, Astulphus fled precipitately to Pavia. Pepin pursued him, and having besieged his capital, granted him peace on condition of his restoring the places which he had seized in the Roman dukedom, together with the exarchate and Pentapolis, to the pope. Hostages were also delivered in order to secure the fulfilment of this condition. Astulphus, regardless of his oath and hostages, invaded the Roman dukedom, seized several cities, and besieged Rome itself. In this extremity, Stephen had again recourse to his protector, who, highly incensed at the treachery of Astulphus, marched again into Italy, and closely invested Pavia, into which the Lombard king had retired. Astulphus once more sued for peace, which was granted him upon his promising to perform immediately the treaty made the year before, and, besides, to surrender to the pope the city of Commachio, which was then a place of great importance. Pepin then renewed his donation; and having caused a new instrument to be drawn up, he caused it to be delivered, signed by himself, by his two sons, Charles and Carloman, and by the chief barons and prelates of France, into the pope's hands. He then left Italy, and returned with his army to France. The exarchate comprised, according to Sigonius (ad ann. 756) the following cities, *viz.* Ravenna, Bologna, Imola, Faenza, Forlimpopoli, Forli, Cesena, Bobbio, Ferrara, Commachio, Adria, Servia, and Secchia, which were all delivered to the pope, except Faenza and Ferrara. Pentapolis, or Morea d'Ancona, comprehended Rimini,

Pesaro, Conca, Fano, Sinigaglia, Ancona, Osimo, Umarna, Jesi, Fossombrone, Monteferetro, Urbino, the Baloesian territory, Cagli, Luceoli, and Eugubio, with their territories and districts. as appears by the donation of Lewis the Pious, by which Pepin's donation was confirmed. The pope committed the government of the exarchate to the archbishop of Ravenna, who thereupon took the title of exarch, not as archbishop, but as an officer of the pope, now a temporal prince. Thus was the sceptre added to the keys, the sovereignty to the priesthood, and the popes were enriched with the spoils of the Lombard kings, and the Roman emperors. As those countries belonged, without doubt, to Constantine their emperor, some authors have thought that this donation was made in his name, and that this gave rise to the fable of the donation of Constantine the Great. Hence it appears that the popes by degrees became sovereigns of Rome. The exarchate of Ravenna, says Petrus de Marca, being yielded to the pope, the government of Rome, of course, devolved upon him; for the Roman dukedom had been always subject to the exarch. The pope, therefore, when he became master of the exarchate, claimed the administration, and continued to govern Rome, not as sovereign, but only with the authority that had been vested in the exarch, till the year 876, when the authority of the emperors, successors of Charlemagne, declining in Italy, Charles the Bald yielded all his claim to, and sovereignty over Rome, to the apostolic see. Hence Constantine Porphyrogenitus, describing the state of Europe in his time, that is, about the year 914, writes, that Rome was subject to the pope, as its sovereign. It was upon the declension of the western empire, when it was confined to Germany alone, that the pope, as well as the several princes of Italy, assumed the sovereignty, which they afterwards enjoyed. The donation of Pepin was confirmed by Charlemagne at the request of pope Adrian; for having ordered Iterius, his secretary, to draw up a new instrument, he signed it himself, caused it to be signed by the abbots, bishops, and other great men, who had attended him to Rome, and, with his own hand, laid it on the altar of St. Peter.

F. Papebroch, in his Propylæum ad Acta Sancti Maii, has a dissertation on the power and office of the exarch of Italy, in the election and ordination of the pope.

The emperor Frederic created Heraclius, archbishop of Lyons, a descendant of the illustrious house of Montboissier, exarch of the whole kingdom of Burgundy; a dignity, till that time, unknown any where but in Italy, particularly in the city of Ravenna. Menestrier. Hist. de Lyons.

Homer, Philo, and other ancient authors, give likewise the name exarchus to the choragus, or master of the singers, in the ancient choruses, or him who sung first; the word αρχων, or αρχουσι, signifying equally to begin, and to command.

EXARCH of a diocese, was anciently the same with primate. This dignity was inferior to the patriarchal, yet greater than the metropolitan.

EXARCH also denotes an officer still subsisting in the Greek church; being a kind of deputy or legate *a latere* of the patriarch, whose office it is to visit the provinces allotted him, in order to inform himself of the lives and manners of the clergy; take cognizance of ecclesiastical causes; the manner of celebrating divine service; the administration of the sacraments, particularly confession; the observance of the canons; monastic discipline; affairs of marriages, divorces, &c. but, above all, to take an account of the several revenues which the patriarch receives from several

churches; and particularly as to what regards the collecting of the same.

The exarch, after having greatly enriched himself in his post, frequently rises to the patriarchate itself.

EXARCH is also used, in the *Eastern Church Antiquity*, for a general, or superior over several monasteries; the same that we otherwise call archimandrite: being exempted, by the patriarch of Constantinople, from the jurisdiction of the bishops; as are now the generals of the Romish monastic orders.

In 493, Sebas was established exarch, or chief, of all the anchorets within the territory of Jerusalem. Du Bois.

EXA'RMA, from εξαρμαι, to be elevated, in Surgery, a high, prominent, swelling.

EXARTHREMA, from εξ, out of, and αρθρον, a joint, an old term, having the same signification as the word dislocation. See LUXATION.

EXA'RTHROS, from εξ, out of, and αρθρον, a joint, a term denoting a person whose joints are so large and mis-shapen, that they look as if they were luxated.

EXARTICULATION, a dislocation of some of the jointed bones; or a breach of articulation. See LUXATION.

EXAUCTORATIO, among the Romans, differed from *missio*, or a discharge. In the latter, the soldiers were quite dismissed from the service; and this was done after they had served twenty years: but in the former case, they only lost their pay, being still kept under their colours or *vexilla*, though not under the eagle, *aquila*, which was the standard of the legion. Whence, instead of *legionarii*, they were called *subsignani*, and were still retained till they had either served out their time, or had lands assigned them. The *exauctoratio* commonly took place after they had served seventeen years.

EXAUDET, in *Biography*, a performer on the violin in the opera band at Paris from 1749 to 1760; remarkable for nothing as a composer, but for the minuet which bears his name in France, and which in England is better known by the title of "Marshall Saxe's Minuet," the best "Minuetto per ballo," or for dancing, perhaps, that ever was composed.

EXCALCEATION, *ex, off, and calceus, shoe, discalceation*, or the act of putting off the shoes.

Among the Hebrews there was a particular law, whereby a widow, whom her husband's brother refused to marry, had a right to summon him into a court of justice; and, upon his refusal, might excalceate him, *i. e.* pull off one of his shoes, and spit in his face; which were both actions of great ignominy among that people.

The house of the person who had undergone them was thenceforward called the house of the excalceated.

EXALCED, EXCALCEATI, different orders of friars, hermits, and nuns, who amongst their other austerities went barefooted, or wore nothing on their feet but sandals, were distinguished by the name of excalced, as the Franciscans, Carmelites, Poor Clares, &c. whilst other branches of the same institute, but less rigid, were called calced, from their members wearing shoes. A particular branch of the Waldenses, Vaudois, or poor men of Lyons, in the 12th century, laid great stress on the wearing of sabots or wooden clogs instead of shoes, and therefore obtained the name of Sabatati and Infabatati.

EXCAMBIATOR. See EXCAMBIO, and EXCHANGE.

EXCAVATION, formed of *ex, and cavus, hollow, or cave, a pit, &c.* the act of hollowing or digging a cavity, particularly in the ground.

The excavation of the foundations of a building, by the Italians

Italians called *cavatione*, is settled by Palladio at a sixth part of the height of the whole building: unless there be cellars underground, in which case he would have it somewhat more.

EXCAVATION of *Vallies*, in *Geology*, is a subject which has exercised the thoughts of many ingenious men, the greater part of whom have supposed that these stupendous and important operations were effected by violent currents of water, which at some period made their way down them: but a more careful examination has shewn, that in scarcely any instances are the excavated materials to be found, or any part of them, as must inevitably have happened at the bends and junctions of vallies, particularly those which lie far inland, had the mere washing of water been the cause of vallies: but Mr. Farey, and Dr. William Richardson, have of late, and separately as it should seem, come to the conclusion (*Philosophical Magazine*, vol. xxxiii. p. 204 and 262.) that these excavations were effected by causes acting "from above the surface of the earth," which completely carried off the matter which once filled up the vallies, and originally joined those corresponding parts of strata, whose edges are now in a great number of instances to be traced in their opposite sides: these opinions of the former gentlemen have been already slightly noticed, and referred to, in our articles COAL, COLLIERY, and others.

EXCELLENCY, a quality, or title of honour given to ambassadors, and other persons, who are not qualified for that of highness, as not being princes; and yet are to be elevated above the other inferior dignities.

In England, and France, the title is now peculiar to ambassadors: but it is very common in Germany and Italy. Those to whom it was first appropriated were the princes of the blood of the several royal houses; but they quitted it for that of highness, upon several great lords assuming excellency.

The ambassadors have only borne it since the year 1593, when Henry IV. of France sent the duke de Nevers ambassador to the pope, when he was first complimented with excellency. After that, the same appellation was given to all the other ambassadors residing at that court; from whence the practice spread through the other courts.

The ambassadors of Venice have only had it since the year 1636, when the emperor and king of Spain consented to allow it them.

The ambassadors of the crowned heads dispute the giving of that title to the ambassadors from the princes of Italy; where the practice is not established.

The court of Rome never allowed the quality of excellency to any ambassador who was a churchman, as judging it a secular title. The common rules and measures of excellency were a little variable, with respect to the court of Rome. The ambassadors of France, at Rome, anciently gave the title of excellency to all the relations of the pope then reigning; to the Constable Colonna; to the duke of Bracciano, and the eldest sons of all those lords; as also the dukes of Savelli, Cesarini, &c. But they have been since more reserved in this respect; though they still honoured all the Roman princeesses with excellency.

The court of Rome, in their turn, and the Roman princes, bestowed the same title on the chancellor, ministers, and secretaries of state, and presidents of the sovereign courts of France; the presidents of the councils in Spain; the chancellor of Poland; and those of the first dignities of other states, if they were not ecclesiastics.

The word excellency was, anciently, a title of kings and emperors; accordingly Anastasius the library-keeper calls Charlemagne his excellency. The same title is still given

to the senate of Venice: where, after saluting the doge under the title of *serenissimo*, the senators are addressed under those of your excellencies. The *Liber Diurnis Pontif. Rom.* gives the title excellency to the exarch and patricians.

The Italian and French have improved on simple excellency; and made *excellentissimo*, and *excellentissime*, which have been bestowed on certain popes, kings, &c.

EXCELSIS. See GLORIA in *excelsis*.

EXCENTRIC, in *Geometry*, is applied where two circles, or spheres, though contained, in some measure, within each other, yet have not the same centre; and, consequently, are not parallel; in opposition to concentric, where they are parallel, having one and the same common centre. The sun's orbit is excentric, with regard to the globe of our earth: Mars is very excentric, with regard to the sun; that is, his motion is about a very different centre.

EXCENTRIC *Theory*, in *Ancient Astronomy*, one of the theories adopted by the ancient astronomers to explain and calculate the different irregularities which they had observed to take place in the motions of the heavenly bodies.

It is not exactly ascertained at what period practical astronomy had attained sufficient perfection to indicate the necessity of such a theory. Probably both the Indian and Egyptian astronomers were early acquainted with the more obvious inequality in the sun's orbit; but Hipparchus is the first astronomical writer who seems to have aimed at determining it with any degree of precision.

The theory embraced by Hipparchus is said to have been first taught in Greece by the disciples of Pythagoras. Though their knowledge on the subject is supposed to have been derived from the oriental nations, yet it is highly probable they contributed to strengthen the prejudices in favour of circular and uniform motion, which afterwards proved the source of so much difficulty and error in all the systems of ancient astronomy. It was from this prejudice, early assumed as a principle, that nature could not, consistently with the observed simplicity of her designs, adopt any other form for the celestial orbits than that of perfect circles, nor any other motion than what was perfectly uniform. The problem, therefore, that occupied the astronomers and philosophers of those days, was to explain the various irregularities which they observed in the planetary motions, without infringing on the above principle.

There were two theories chosen for this purpose, nearly equivalent in their principle, the concentric and the excentric.

In the concentric theory the earth was supposed to be placed in the centre of a circle, on the circumference of which the centre of another circle revolved, and on the circumference of this second circle, called an epicycle, the planet was supposed to move. The first circle was called the *deferent*, and by assigning a suitable ratio to the deferent circle, and to its corresponding epicycle, some of the more obvious irregularities were pretty accurately represented. *Fig. 110. Plate XIII. Astronomy*, is the representation of the concentric theory. Let C be the centre both of the earth and of the circle F B D, and let H G K be a smaller circle, or epicycle, whose centre B moves uniformly in the circumference F B D, from west to east, or *in consequentia*, while the sun moves also uniformly and with the same velocity in the circumference of the epicycle, *in antecedentia* in the upper part, but *in consequentia* in the lower part. If the point G of the epicycle, called its apogee, as being most distant from the earth, be supposed at the beginning of the anomalistic revolution to be placed in the point A of C F produced; and if when it comes to G, the arc G H be taken similar to F B, the point H will

be the place of the sun when the centre of the epicycle has moved from F to B. If then in CF, to which BH is parallel, we take CE = BH, and on E as a centre, with the distance EA = CF, describe the circle AHP, the sun would be seen from E to move in this circle equably; for the angle AEH is equal to the angle FCB; but seen from C, the centre of the earth, it will appear to move in it inequably; for the angle ACH, in the first circle of anomaly, that is, in the passage of the sun from A to P, is always less than AEH or FCB; and its true place H will be less advanced in longitude than its mean place B. When again the centre of the epicycle or the mean place of the sun, having described a semicircle, shall have come to D, the sun, having described a semicircle of the epicycle, will be found in P, the perigee of the orbit AHP, and its mean and true places B and H will be seen from C to coincide as they did in the apogee A. But in the sun's passage from P to A, that is, in the second semicircle of anomaly, his true place H, as seen from C, will be always more advanced in longitude than his mean place B: for in this semicircle the angle PCH is always greater than PEH or DCB. The angle EHC or BCH, which is the difference between the mean and true places of the sun, is called the equation of the orbit, and it is evident that this equation will be greatest in N or M, where the centre B of the epicycle is 90° distant from either of the apses.

It was thus that the ancients originally proceeded in their representation of the solar inequalities, and the representation seemed to be sufficiently justified by observation: at least, till the days of T. Brahé, no observations had been made with sufficient accuracy to subject it to suspicion. Their success also, while no lunar inequality except the simple anomalistical one was discovered, was equal in the application of the same concentric theory to the motions of the moon: and having, in two cases, thus successfully, by means of one subordinate sphere or epicycle, reconciled apparent inequality of motion with real uniformity, it was natural to suppose that other inequalities, though more various and complicated, might be explained in a similar manner, and required only the addition of other epicycles. The same method of procedure, therefore, was continued, and every new inequality which observation discovered, was accounted for by a new sphere or epicycle producing it, till the whole number employed in the system amounted to 34. Aristotle, on narrower examination, found these insufficient, and added to them 22: but still they were deemed insufficient; and the number was at last increased to 72. But though it was not till long after the days of Aristotle, that the theory was carried to such a degree of extravagance, the multiplication of epicycles rendered it, even in his time, almost as intricate and complex as the appearances which it was intended to explain. Some examples of this kind will occur on the revival of it by Copernicus and T. Brahé: and when Hipparchus and Ptolemy introduced excentric orbits, and by means of them somewhat diminished the multiplicity of the spheres employed by their predecessors, they were thought to do a signal service to astronomy.

The manner in which Hipparchus explained the solar inequalities, in his excentric theory, was to this purpose. Let O (fig. III.) be the centre of the earth and of the starry sphere. Let BCDE be the ecliptic, or great circle in the *primum mobile* in which the sun seems to perform his annual revolutions; and, in the same plane, but on a different centre Z, let the circle ALP be described. This is the circle, or orbit, in which the sun is supposed actually to move, and to describe round its centre equal arcs or angles in equal

times: or rather, he is supposed to be carried round by the equable motion of the circle itself; which, because its centre is not occupied by the earth, is called an excentric circle. It is evident, in this representation, that if the earth were placed in Z, a spectator on it would perceive the sun, since he is supposed to move uniformly in the excentric, to move also uniformly in the ecliptic. But the earth is placed in O, at the distance OZ from the centre of the excentric; and therefore, when his motions are referred to the ecliptic by a spectator in O, they must appear unequal. When, for example, he departs from A the apogee of the excentric, and comes to K, he would be seen from Z in the point R of the ecliptic; but from O, the centre of the earth, he is seen in C, a point less advanced in longitude. On the contrary, when he departs from P, the perigee of the excentric, and comes to N, his place in the ecliptic, as seen from Z, is the point V; but seen from O it is the point F, more advanced in longitude than V. Any line, as ZK, drawn from the centre of the excentric to the sun, or any parallel to it drawn from O, is called the line of mean motion, and determines the mean anomaly AZK; and any line, as OK, drawn from the sun to the centre of the earth, is called the line of true motion, and determines the true anomaly AOK; and the angle OKZ, which is the difference between the mean and true anomalies, is the equation of the orbit. In the apogee and perigee this equation vanishes, in the same manner as in the concentric theory; because there the lines of mean and true motion coincide; and at the points L, L, where a perpendicular to the line of apses, drawn through O, meets the excentric, it comes to its greatest amount. Thus, by the single supposition that the solar orbit was excentric to the earth, Hipparchus supplied the place of the epicycle added to the concentric: nor is it difficult to perceive that the representations, given by both theories of the solar inequalities, were in their effects precisely the same.

In both these theories, it is evident that the inequalities of the sun were considered as purely optical: and what was principally required was to find the point O, in the line AP of the apses, in which the earth must be situated, in order to give to the solar motions the just inequality which observation required; and to determine the longitude A of the solar apogee, that is, the point B of the ecliptic to which it is referred from O. Without finding the just excentricity OZ, the calculated differences, or equations, between the sun's mean and true places, would not correspond with the observed differences: and without discovering the position of the apogee, the calculated equations, however accurate, would not be applied in their proper places. In these investigations the procedure of Hipparchus was as follows.

Let B (fig. 112.) be the place of the sun at the vernal equinox, BD an arc of the excentric equal to his mean motion for 94½ days, that is, from the vernal equinox to the summer solstice, DF an arc equal to his mean motion for 92½ days, or from that solstice to the autumnal equinox: let the chord BF be drawn, and from D another chord DE perpendicular to BF. The point E of the intersection of these chords is evidently the point where the earth must be situated: for it is the only point from which B, D, F, G, can appear at the distance of 90° from one another, and as they appear actually in the heavens.

It was required, therefore, to determine the excentricity EC, or the distance of the point E from C, the centre of the solar orbit. Since the arc BDF of the mean motion, and which the ancients supposed to be the only real motion of the sun, from B the vernal to F the autumnal

nal equinox, is given by means of the annual revolution, and consists of  $184^{\circ} 20'$ , its half BH will consist of  $92^{\circ} 10'$ . Through H draw the diameter HC; and through C the centre of the orbit, the diameter CK perpendicular to HC, and meeting DE in L; and join CE. If from BD, the mean motion for  $94\frac{1}{2}$  days, and  $=93^{\circ} 9'$  we subtract BH  $=92^{\circ} 10'$ , the remainder DH will be found  $=59'$ : and if from BH we subtract the quadrant KH, the remainder BK will be  $=2^{\circ} 10'$ . Therefore CL and EL, the sines of the arcs DH, BK, will be given in parts of CD  $=10,000$ ; the former to wit  $=172$ , and the latter  $=378$ . Therefore the excentricity EC, being the hypotheuse of the right-angled triangle ELC, will be found in the same parts: for  $EC^2 = CL^2 + EL^2$ , and therefore  $EC = 415$ .

By producing EC to meet the excentric in A and P, we shall have the line AP of the apsidcs: and the longitude of A the apogee will be found from the same triangle ELC; for  $CE : EL :: R : \sin. ECL = KCA = BEA = 65^{\circ} 30'$ . Since B therefore represents the point of Aries, the place A of the apogee fell short of the solstitial point D,  $24^{\circ} 30'$ , in the days of Hipparchus. It is now between  $9^{\circ}$  and  $10^{\circ}$  more advanced.

When the excentricity and the longitude of the apsidcs were thus determined, the equations of the orbit, or the differences between the mean and true places of the sun, were obtained by a very simple trigonometrical computation. For in the excentric theory, (fig. 111.) when this equation comes to its greatest magnitude, in the points L, L, or M, M, where perpendiculars to the line of apsidcs drawn through O or Z meet the excentric, the excentricity OZ becomes the tangent of the angle ZMO to the radius of the orbit ZM: and at any other point K, with the excentricity OZ, the radius ZK, and the angle KZO the supplement of the mean anomaly AZK, the equation ZKO will be found by the analogy  $KZ + ZO : KZ - ZO :: \tan. \frac{1}{2} AZK : \tan. \frac{1}{2} (ZOK - ZKO)$ . The calculation will be precisely the same in the concentric theory if EC be taken in CA, (fig. 110.) equal to the radius of the epicycle, that is, to the excentricity OZ, (fig. 111.) and will produce the same results: and the excentric theory will be found to differ from the concentric only in simplicity. It is probably needless to observe that the parallels OL and ZM will mark the same point in the zodiac.

Though these theories were thought sufficient to explain the solar motion, in that imperfect state of practical astronomy, yet they were found entirely to fail when applied to the observed motions of the moon and planets. A new scheme was therefore adopted by Ptolemy, in which, however, the principle of uniform motion was in fact abandoned. This consisted in assuming an imaginary point as the centre of a new circle, called the equant; and it was supposed that to a spectator situated in that point the motion of the planet would appear to be uniform. It is not now exactly known if the Greek astronomers invented this theory, or if they received it by tradition from the eastern nations, but it is a curious circumstance to observe, in the history of the science of astronomy, how very near the truth the ancients arrived by trial and observation; for their deferent circle and epicycle reduced the figure of the orbit really to an oval form, and the two points in which they placed the earth and the centre of the equant were many centuries afterwards discovered to be no other than the foci of an elliptic orbit. The true theory was kept out of sight by an obstinate adherence to an ancient prejudice, for what a singular method was nature supposed to take, in order to adhere to this principle of uniform and

circular motion; after a number of unmeaning efforts, she only accomplished an *apparent* uniform motion round an imaginary point, in which no spectator could ever possibly be placed to admire the beauty of the contrivance:

The mode of determining the equant was as follows.

Let A be the centre of the earth, (fig. 113.) suppose the centre of the world D, the centre of the orbit of a planet, or of the excentric circle, F K M L E, called the deferent, (see EPICYCLE.) Upon the point F is described the epicycle G Q, and above D a point E is assumed, equal to the excentricity AD, and from the point E another circle is described, R K O L R, of the same magnitude as the deferent. This second circle is called the equant, because the centre of the epicycle, which moves upon the deferent, has nevertheless an equal motion round the centre E of the equant, for the epicycle describes its deferent with an unequal motion, which should disappear when referred to the centre of the equant, so that the angle, such as FEI, formed by the line of apsidcs AF, and by the line drawn to the centre of the epicycle, arrived at I, may be always equal in equal times; for this reason Ptolemy calls the point E the point of equality. The angle FAI is the true anomaly of the excentric, the angle FEI the mean anomaly, and which is always formed at the centre of the equant.

Kepler had endeavoured to explain physically the cause of the equant, that is, why there should be a point E different from the point D, about which the motion was regular and uniform, (Mystr. Cosmog. c. 22.) He was persuaded the cause was general, and that the equant must take place in the orbit of the earth, as well as in the other planets. Neither Tycho nor Copernicus had employed an equant, but Kepler was persuaded that the points E and D in an excentric were not the same, particularly when Tycho informed him that the annual orbit, or excentric of the sun, appeared to him not to be always the same.

Kepler suspected that this variation arose from the point of equality not being the centre of the circle; and in the course of his investigation of this question, he was led to the discovery of the bisection of the excentricity in the case of the earth, whereas the ancients only admitted it in the case of the superior planets. See EXCENTRICITY, *bisection of*.

EXCENTRICITY of the Orbit of a Planet, in Astronomy, is the distance between the centre and the focus of the ellipse in which it revolves. The discovery of the excentricity in the orbits of the sun and moon is attributed to Hipparchus, who wrote a treatise on this subject 150 years before our era.

The excentricity of the orbit is computed from the greatest equation of the centre, by the following proportion: As  $57^{\circ} 17' 44''.8$ , (the arc = rad.) is to half the greatest equation, so is rad. = 1 to the excentricity. See EQUATION, and ELLIPTIC Motion.

But when the greatest equation has been found, and accurately determined by observation, the excentricity may be practically deduced by using the rule of false position, or by supposing the excentricity known, and finding by trial the greatest equation corresponding to it.

The excentricities of the planetary orbits are usually calculated on a scale which supposes the mean distance of the earth from the sun divided into one hundred thousand parts, and the excentricity is expressed in proportional parts of that scale.

The following formula for calculating the excentricity is given by Lambert in the Ephem. de Berlin.

Let

Let  $E$  be the greatest equation of the centre,  $e$  the excentricity, make  $\frac{E}{57} = \alpha$ .

The excentricity will then be expressed by the following series.

$$e = \frac{1}{2} \alpha - \frac{11}{768} \alpha^3 - \frac{587}{93040} \alpha^5 - \frac{40583}{2642411520} \alpha^7 - \dots$$

The quantity  $\alpha$  is always a small fraction, particularly for the sun; if we suppose with La Place,  $E = 2^{\circ}.1409$  decimal for 1750. Then,

$$\alpha = \frac{2.1409}{63.6620} = 0.033629$$

$$\frac{1}{2} \alpha = 0.016814.$$

The second term,  $\frac{11}{768} \alpha^3$ , is less than 0.000001, and may therefore be entirely neglected.

TABLE of Excentricities according to different Authors.

Planets.	Kepler.	Cassini.	Halley.	La Lande.	Log. of Excen. in parts of the mean distance.
Mercury	8150	8092.1	7970	7955.4	9.3128399
Venus	501	517	504.985	498	7.8378910
The Sun	1800	169	1691.90	1681.395	8.2253628
Mars	14115.5	14155	14170	14183.7	8.9688921
Jupiter	25074	2506	25078.6	25013.3	8.6819346
Saturn	54143.5	5432	54381.4	53640.42	8.7499109
Herfchel				90804	8.6774873

The following table of excentricities in parts of the major axis is taken from the "System of the World," by La Place.

Mercury	-	0.205513
Venus	-	0.006885
Earth	-	0.016814
Mars	-	0.093808
Jupiter	-	0.048877
Saturn	-	0.056223
Uranus	-	0.046683

The secular variation of these numbers is as follows: (the sign - indicates a diminution.)

Mercury	-	+ 0.000003369
Venus	-	- 0.000062905
The Earth	-	- 0.000045572
Mars	-	+ 0.000090685
Jupiter	-	+ 0.000134254
Saturn	-	- 0.000261553
Uranus	-	- 0.00026228

**EXCENTRICITY, bisection of.** The bisection of the excentricity is a curious principle assumed by Ptolemy, and the ancient astronomers, to explain the irregularities of the planetary motions. It is thus described by Dr. Small.

The inequalities of the planets were so various and intricate, that the explications of them were for a long time extremely imperfect, and so partial, that no Grecian astronomer before Ptolemy had supposed it practicable to give a compleat theory of all. In the more ancient times the explications of them appear to have been made by orbits concentric to the earth, and charged with epicycles: but, as Ptolemy had found no method of representing the second inequalities, except by means of epicycles, so, to avoid the perplexity occasioned by the multiplication of them, he gave the preference to an excentric orbit for the

representation of the first; and, by the superior simplicity of the representation, the authority of the excentric theory was for many centuries established. With respect to those first inequalities, at least of the superior planets, it appears to have been originally supposed, that they might be sufficiently accounted for by the more simple solar hypothesis. For, if the planet, in consequence of its second inequalities, be represented as moving in the circumference  $abc$  (fig. 111) of an epicycle, the centre  $ALPQ$ , of this epicycle, will represent the places which it would occupy, if it were divested of all second inequality: and it was thought a sufficient explication of the first inequality, to suppose that this centre moved equally round  $Z$ , the centre of the orbit, and consequently inequally round  $O$ , the centre of the earth. But when, according to Kepler's conjectures on this subject, they endeavoured to account for the inequality of the latitudes in opposition, and of the digressions of the planets, especially their greatest digressions, from the point opposite to the sun, by variations of their distances from  $O$ , it appeared that the point  $Z$ , round which the planet moved equably, could not be the same with the centre of the orbit; for, both the latitudes, and also the angles  $aOe$ ,  $dOf$ , which the epicycle subtended at the centre of the earth, were found to be greater at the apogee, and less at the perigee than the limits of the excentric  $ALPQ$  permitted; and that, consequently, the centre of the orbit occupied a place nearer than  $Z$  to the centre of the earth. It was therefore a matter of much greater difficulty to form an hypothesis for the motions of the planets, than for those of the sun: for, if their first inequalities required one determined excentricity, or distance between the centre of uniform motion and the centre of the earth, the variations of their latitudes, and of their second inequalities, shewed that this was not the excentricity of the orbit in which the epicycle moved, and that this orbit evidently required another. In what proportion the distance  $ZO$  between the centre of uniform motion and the centre of the earth ought to be divided by the centre of the orbit, appears to have been for a long time a matter of much uncertainty. But Ptolemy tells us that, on applying himself to investigate the measure of the approach of the centre of the epicycle, within the circle  $ALPO$  at the apogee, and its consequent withdrawing from it beyond the perigee, he found, by multiplied observations, that the centre of the orbit lay precisely in the middle, between  $Z$  the centre of uniform motion, and  $O$  the centre of the earth. This is the famous principle, known by the name of the bisection of the excentricity: and, as Ptolemy gives no account of the means by which it was discovered, nor of the observations from which it was inferred, his assuming it has justly excited the wonder of all astronomers. The greater part believed him to have assumed it merely from conjecture, and not to have derived it, as Kepler more generously supposed, from any observations; and there seems to be some reason for thinking that it came to him by tradition, from the more ancient astronomy of the East.

**EXCEPTIO**, in the Roman Law. See PLEADING.

**EXCEPTION**, something reserved, or set aside, and not included in a rule.

It is become proverbial, that there is no rule without an exception; intimating, that it is impossible to comprehend all the particular cases under one and the same maxim. But it is dangerous following the exception preferably to the rule.

**EXCEPTION**, in Law, is a stop or stay to an action.

The term is used indifferently, both in the civil and common

mon law; and in each exceptions are divided into *dilatory* and *peremptory*.

In law proceedings, exception is a denial of a matter alleged in bar to the action; and in chancery it is that which is alleged against the sufficiency of an answer, &c. Exception, in a general sense, includes all the kinds of defence, or vindication, which a person, against whom a process is brought, makes use of to prevent or retard its effect.

The civilians reckon three kinds of exceptions; *viz. declinatory*, whereby the authority of the judge or court is disallowed; *dilatory*, intended to defer or prevent the thing from coming to an issue; and *peremptory*, which are proper and pertinent allegations, founded on some presumption that stands for the defendant; as want of age, or other quality, in the party; or other matter that may be decided, without entering into a full discussion of the merits of the cause.

EXCEPTION *to evidence*, is where a demurrer is offered in any civil cause, on account of the insufficiency of the evidence given, and the court does not agree to it; in which case the court or judge are required to seal a bill of exceptions, by stat. Westm. 2. 13 Edw. I. cap. 31. which is in the nature of an appeal, examined in the next immediate superior court, upon a writ of error after judgment given in the court below. See DEMURRER, and EVIDENCE.

EXCEPTION, *in deeds and writings*, is the saving of a particular thing out of a general one granted by deed, as a room, shop, or cellar, out of a house; a field, or timber-trees, out of land, &c. Exceptions of this kind must not cross the grant, nor be repugnant to it, or else they are void of course; yet there may be a kind of exception, or saving out of an exception, so as to make a thing as if never excepted; as where a lease is made of a rectory, excepting the parsonage-house, saving to the lessee a chamber, this shall pass by the lease.

EXCEPTIVE CONJUNCTION. See CONJUNCTION.

EXCEPTIVE *propositions*, are those wherein something is affirmed of a whole subject, abating some one of the parts thereof, which is *excepted* by a particle, thence called an exceptive particle, or particle of exception.

Thus, "All the sects of the ancient philosophers, except the Platonists, held God to be corporeal. Covetousness is inexcusable in respect of every thing, but time."

EXCESS is distinguished into *natural* and *moral*: the first, is a part whereby one quantity is greater than another. Thus, we say, this line is longer than that; but the excess is inconsiderable.

The latter is an intemperance, or going beyond the just bounds and measures prescribed for any thing. Thus, we say, excess in wine, women, &c. is prejudicial to the health.

EXCESSIVE, in *Music*, is used as a prefix to denote the excess of certain tempered intervals above the true intervals of the same name; it is generally opposed to defective, *viz.* when there is a deficiency to the same extent as there is here an excess; but their use is not limited to any certain quantity of excess or defect, they being sometimes applied in conjunction with or to represent the diatonic, sometimes with enharmonic diatonic, at others with minimum semitone, &c.; whereas the prefixes, redundant and deficient, are used only with the major comma, and hence the word comma is sometimes omitted; and in like manner the prefixes superfluous and diminished are confined to the minor semitone, which last word is therefore sometimes omitted in naming the class of intervals, which are increased or lessened by a minor semitone.

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EXCHANGE, in *Commerce*, and *Political Economy*, is the act of paying or receiving money in one country for its equivalent in the money of another country, by means of bills of exchange.

This science, therefore, comprehends both the reduction of monies, and the negociation of bills: it determines the relative value of the currencies of all nations, and shews how foreign debts are discharged, loans and subsidies paid, and other remittances made from one place to another, without the risk or expence of transporting specie.

This important subject may be considered under the five following heads, namely:

1. Bills of exchange.—2. Par of exchange.—3. Course of exchange.—4. Monies of exchange.—5. Arbitration of exchange.

*Bills of exchange*.—A bill of exchange is a written order for the payment of a certain sum of money at an appointed time. It is a mercantile contract in which four persons are mostly concerned, *viz.* 1. The *drawer*, who receives the value. 2. His debtor in a distant place, upon whom the bill is drawn, who is called the *drawee*, and who is to accept and pay it. 3. The person who gives value for the bill, and who is called the *buyer* and *remitter*; and, 4. The person to whom it is ordered to be paid, who is called the *payee*, and who may, by indorsement, pass it to any other holder.

Most mercantile payments are made in bills of exchange, which, until due, generally pass from hand to hand, like any other circulating medium. The laws of all trading nations afford the most ready and effectual means of enforcing the payment of bills, and hence that credit which they so universally obtain, and which greatly facilitates the operations of commerce.—For the laws, customs, and regulations of bills of exchange, see BILL of exchange, and *Mercantile Law*. See also AGIO, USANCE, and DAYS of Grace.

Bills are distinguished into inland and foreign, according as they are made payable in the country where they are drawn, or in a foreign country. Their functions, however, are similar in both cases, and therefore in explaining the theory of exchange, we shall begin with the operations of inland bills as the most simple and familiar.

Suppose A. of London is creditor to B. of Edinburgh 100*l.* and C. of London debtor to D. of Edinburgh 100*l.* these two debts may be discharged by the operation of one bill: thus, A. draws on B. and sells his bill to C. who remits it to D. and the latter receives the amount from B. when due. Here, by a transfer of claims, the London debtor pays the London creditor, and the Edinburgh debtor the Edinburgh creditor.

By the foregoing example it appears that reciprocal and equal debts due between two places, may be discharged without any cash remittance, and it may be supposed that such an operation is of equal convenience to the parties concerned, in both places; but when debts are unequal, the advantage must be likewise different, as the obligation of remittance is no longer mutual; for the debtor place must pay its balance either by sending cash or bills; and as the latter mode is generally preferred for several reasons, an increased demand for such bills must be the consequence; and this enhances their price, as it would that of any other saleable article.

This is the plain principle of exchange which is constantly exemplified in the premium paid for inland bills on London; for this city, being the grand emporium of commerce that furnishes most other places of the kingdom with foreign merchandize, and being also the residence of

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numerous landlords whose rents must be remitted to them from the country, it has generally a large balance of debt in its favour, a great part of which must be sent in bills; this creates a demand, and consequently a premium which is mostly commuted for time; thus, if A. of London be creditor to B. of Edinburgh 200*l.* and C. of London debtor to D. of Edinburgh only 100*l.* the balance of 100*l.* against Edinburgh cannot be cancelled by a transfer of claims, but must, we will suppose, be remitted by a bill, which can be only obtained at a certain number of days after date. The most general term for bills from Edinburgh on London is 40 days, and the interest for this time is about  $\frac{1}{2}$  per cent. The number of days here is called the exchange, which has been known to vary considerably according to the balance of debt, or the plenty or scarcity of bills. A similar premium or date is allowed for bills from all other places of Great Britain on the capital, but bills at sight on any of those places may be generally had in London without any premium whatever.

Although the principle of foreign exchange is the same as that of inland, yet the former is more complicated in its operations than the latter, owing to the denominations of money not being the same. This causes a difference in the mode of paying the premium for bills; in which, however, the date is taken into consideration as well as the comparative rates at which the monies are valued.

In foreign exchange one place always gives another a fixed sum or piece of money for a variable price, which fluctuates according to the balance of debt, as before stated: the former is called the certain price, and the latter the uncertain price. Thus London is said to give to Paris the certain for the uncertain; that is, the pound sterling for a variable number of francs; and to give to Spain the uncertain for the certain; that is, a variable number of pence sterling for the dollar of exchange.

Whatever the uncertain price is, at any time, is called the course of exchange. Now suppose Paris gives London 25 francs for the pound sterling, and that this sum is found to contain the same quantity of pure silver as 20 shillings, then the exchange is said to be at par; but if France should give a higher price, it is said to be in favour of London, and *vice versa*. This is the common mode of judging whether the exchange be favourable or unfavourable to a place, though it is not always the correct method, nor that which merchants generally act upon. But before we enter into any further explanation of the course of exchange, or the causes of its fluctuation, it will be necessary to explain more fully what is to be understood by the par of exchange, a subject on which there is some difference of opinion, even among writers of the first authority.

### *Par of Exchange.*

The par of exchange may be considered under two general heads; namely, the *intrinsic par*, and the *commercial par*, each of which admits of subordinate divisions and distinctions.

The intrinsic par of exchange is the value of the money of one country compared with that of another, with respect both to weight and fineness. Thus, two sums of different countries are intrinsically at par when they contain an equal quantity of the same kind of pure metal, separated from its alloy, which is always deemed of no value. See COIN.

There should be two intrinsic pars, the one between gold coins, and the other between silver coins; and hence

the intrinsic par of exchange can be only determined with accuracy between places which pay their bills in the same kind of metal, as between England and Portugal, that pay in gold coin; or between France and Spain, that pay in silver coin, for the relative value between these metals is scarcely ever the same in any two countries.

It may be even observed, that the value of the same metal differs considerably in different countries, and therefore this intrinsic par of exchange cannot be always considered as a true equality in the value of monies; thus in the case of France and Spain, where the latter country supplies the former with the materials of her silver coinage, silver must be most valuable in France, and the difference should be equivalent to the charges attending the removal, such as the duty paid (in time of peace) to the Spanish government, for the exportation of dollars, the expences of carriage, insurance, commission, interest, &c. all of which amount to nearly 7 per cent.

A similar computation might be made between gold in England and in Portugal, as the latter country supplies the former with the materials of her gold coinage.

But where one country pays its bills in gold, and another in silver, no intrinsic par of exchange whatever can be permanently established. An equivalency can be only ascertained by valuing as merchandize the gold of one place, and the silver of the other, according to the market price of the day; but this is the commercial par, which shall be more fully explained below.

In ascertaining the intrinsic par between coins of the same metal, a question occurs, whether the computation should be made according to the mint regulations of the respective countries where the monies are struck, or according to actual assays. The former is the most general method, though the latter is certainly the most correct; for while some governments make coins according to their full standard, as in England, others take advantage of the allowance for remedy, and sometimes make it a source of considerable emolument.

There are some countries with which no par of exchange, either intrinsic or commercial, can be permanently fixed. These are such as pay their bills in paper, which must have a fluctuating and precarious value. Even the bank money of Amsterdam and Hamburg comes in a certain degree within this description, as it bears a fluctuating agio against currency.

The *commercial par* is the comparative value of the monies of different countries, according to the weight, fineness, and market price of the metals. This is the par which merchants generally consider of importance in their exchange speculations, and we cannot define it better than in the following passage, taken from the Minutes of the Committee of the House of Commons, appointed in 1804, to enquire into the state of exchange between Ireland and England. Several of the most intelligent merchants of both countries were examined on the occasion, and their evidence produced much new and practical information.

In the examination of Benjamin Winthrop, esq. governor of the bank of England, an interesting enquiry and investigation took place respecting the par of exchange, from which the following appropriate question and answer are extracted.

*Question.*—"When a sum of Hamburg currency, which will buy a pound of bullion of given purity in the market of Hamburg, can purchase a bill for a sum of English currency, which will buy a pound of bullion of the same standard in the English market, is not then the exchange at par between those two countries?"

*Answer.*

## EXCHANGE.

*Answer.*—"I confess it does appear to be a complete par of exchange."

This par of exchange is variously denominated by different writers on political economy; thus it is called the *current*, the *momentary*, the *political*, and the *eventual par*; and though each of these terms seems to convey a correct idea of the subject, yet we have adopted the word *commercial* as equally appropriate and more generally understood.

Some notice might be here taken of what is called a *monetary par*, in which an allowance is made for seignorage and mint expences, and also of a *common* or *estimate par*, which generally differs from the true one; thus the pound sterling of England is estimated at 11 guilders current of Holland; but such definitions are of little utility in the illustration of exchange.

The following opinion on the par of exchange seems to deserve quotation. It is translated from the preface of a most elaborate work, entitled "Dictionnaire des Arbitrages," by Francois Corbaux, published at Paris in 1802.

"Without dwelling any longer," says this author, "on the arbitrary notions which have been formed of the par of exchange, and without seeking to adopt new ones, which might be rendered very numerous, we shall conclude by observing, that although the intrinsic or pretended real par is made the foundation and principal element in the determination of the price of exchange, yet not being the same in the gold as in the silver coins, the pars of these two metals should be kept totally distinct; and that besides, as neither of them finds any direct application in the common course of exchange affairs, it is through ignorance that so much importance has been attached to them, and that they have been considered as the most correct expression of the relative value of the monies of two countries. In short to seek for a true and rational par is to suppose what cannot exist, that is, the fixing of different principles and elements which are subject to continual variation, and, after all, if this could be accomplished, it would present no object of real utility."

However well-founded the opinion of Monsieur Corbaux may be, we think it must be at least satisfactory to merchants to understand the intrinsic par of exchange, and therefore we shall give new tables of it at the conclusion of the present article, computed both in gold and silver, with rules and examples for performing all such calculations; and shall now proceed to the explanation of the course of exchange, which is a subject of great importance, whether we consider it in a commercial or political point of view.

### *Course of Exchange.*

The course of exchange is the current price or proportion between the monies of two places; which is always fluctuating according to circumstances.

When merchants have occasion to draw or remit foreign bills, they meet upon the Royal Exchange, where this kind of business in London must be transacted. The market is constantly attended by exchange-brokers, to whom the wants of the parties who wish to buy or sell bills are privately communicated. These brokers, whose confidential situation demands strict impartiality, bring parties together; and settle the course of exchange for the day, as soon as they learn how the market stands with respect to the number of drawers and remitters. The commission for this business throughout Europe, is *one per mille* (or thousand) which is equally paid by the buyers and sellers of bills.

When the course of exchange rises above par against any country, it is then concluded that the balance of trade is against

that place. Now, if England should import from France goods to the value of 100,000*l.*, and export only to the value of 80,000*l.*, it may cost England 120,000*l.* to pay the whole debt, if it should be publicly known that so great a balance exists, and therefore secrecy is of peculiar importance in this kind of business.

The fluctuations of exchange are mostly greater or less according to the known amount of the balance, and the expence and difficulty of conveying specie. By the expence of such conveyance is meant the carriage and insurance, and by the difficulty the hazard of evading those prohibitory regulations which, in most countries, impede the exportation of coin; and so powerful is the operation of these causes, that the exchange is sometimes very high, or unequal, even between neighbouring countries, affording room for very profitable speculations for those merchants who circulate bills in the way of arbitration of exchange.

An unfavourable state of the exchange with a country furnishes a motive for exporting commodities to it. The merchant under these circumstances can afford to sell his goods as much cheaper as the premium which he receives for his bill amounts to. Hence the course of exchange tends to correct itself, and, in peace, it seldom continues, for any length of time, more unfavourable than the amount of the expences which might be incurred by transporting bullion to pay the balance which is to be remitted; for bullion may be considered the universal currency of merchants, though it is not always of ready or immediate application.

Although an unfavourable balance of trade has been generally considered an invariable cause of an unfavourable course of exchange, yet recent experience has shewn that this is not always the case. Thus, in the investigation already alluded to, which took place in the House of Commons relating to the exchange between England and Ireland, it was demonstrated that the balance of trade was in favour of Ireland, while the course of exchange was highly unfavourable; it was, however, shewn in subsequent publications on the subject by Messrs. Parnell and Forster, that though the balance of trade was in favour of Ireland, the balance of debt was unfavourable, or, in other words, the balance of remittance, on account of the number of Irish absentees resident in England; but perhaps the political state of the country was the chief cause.

In time of war the fluctuations of the course of exchange are sometimes very great, particularly where large remittances are to be made in the way of foreign loans or subsidies. The exchange is likewise lowered by any debasement of the coin of a country, or by the depreciation of any other circulating medium. Even an excess of currency has the effect of turning the rate of exchange against that place where it prevails, as the excess raises the price of all commodities beyond their value in those places where no such redundancy exists. It may, however, be observed, that the nature of exchange operates to effect the general distribution of the surplus specie, and to maintain the level of money throughout the commercial world. In short, in all cases, the exchange tends to an equilibrium.

Although the depreciation of the circulating medium of a country raises the course of exchange against it, the circumstance is not always a disadvantage. Thus, before the reformation of our silver coinage, in the reign of William the Third, the exchange between England and Holland, computed by the standard of their respective mints, was 25 *per cent.* against England, but the current coin of England was more than 25 *per cent.* below its nominal or standard value; and therefore the exchange was virtually in favour

## EXCHANGE.

of England, according to the statement of Dr. Adam Smith.

It may be further observed, that the wealth of a country will sometimes raise the course of exchange against it, on account of its importations of luxuries from abroad. Rich countries are likewise liable to have the course of exchange turned against them by the subsidies which they may have to remit to less opulent states, as before noticed.

Thus in 1793, the trade between Holland and England was completely open; and yet the course of exchange was 10 or 12 per cent. against Amsterdam, owing probably to the balance of trade being so much in favour of London. But, in 1794, when England undertook to subsidize Prussia, large remittances of bills were made through Amsterdam, which caused an immediate fall in the course of exchange between that place and London, even below par: and therefore at subsequent periods of the war, it has been thought prudent by the English government to export specie on such occasions, rather than to turn the course of exchange against London by the operation of remitting large subsidies in bills. During the present war between France and Austria (1809) the latter power has been subsidized by the English government, which has been chiefly done in bills, and this has tended to raise the exchange against England, in the places where those bills were negotiated. But the cause which has operated more powerfully to produce this effect is the great exportation of goods to England, from Germany, France, and Holland, without any adequate importation of English merchandize. Hence the exchange with London has been for some time greatly in favour of those places, while between London and most of the other parts of Europe it has continued nearly at par.

From what has been said respecting the causes, both commercial and political, which produce the fluctuations of exchange, and which frequently counteract each other, the following simple conclusion may be drawn; that whatever produces a demand for bills on any place tends to enhance their value, and therefore the course of exchange rises and falls according to the proportion which exists between the plenty and scarcity of bills, that is, between the demand and the supply.

### *Monies of Exchange.*

The following tables contain the monies of exchange of the principal trading places of Europe, in all their varieties and combinations. Explanations are also given of the quotations or lifts of the courses of exchange, which are transmitted from one country to another for the government and advice of merchants. These quotations seldom give more than the figures of the uncertain prices, omitting the denominations of money and the certain prices, all of which are here explained.

*Note.*—In all the uncertain prices the words *more or less* are to be understood.

### AMSTERDAM.

#### *Monies of Exchange.*

Exchanges are computed in florins, stivers, and pennings; or in pounds, shillings, and pence Flemish.

16 Pennings	= 1 Stiver
20 Stivers	= 1 Florin or guilder
2 Grotes or pence Flemish	= 1 Stiver
12 Grotes or 6 stivers	= 1 Shilling Flemish
20 Shillings Flemish, or 6 florins	= 1 Pound Flemish.

There are two sorts of money in Holland; namely, *banco* and *currency*: *banco* generally bears a premium against *currency* of 4 or 5 per cent. which is called *agio*.

Amsterdam gives to	<i>Quotation explained.</i>	
	Uncertain prices.	Certain prices.
London	{ 34 shillings 8 } grotes Flemish	} for 1 Pound sterling
France	54 Grotes Flemish	— 3 Francs
Spain	99 Ditto	— 1 Ducat of exch.
Portugal	44 Ditto	— 1 Old crusade
Genoa	86 Ditto	— 1 Pezza of 5¼ lire
Leghorn	92 Ditto	— 1 Pezza of 8 reals
Hamburg	34 Stivers	— 2 Marks
Vienna	20 Ditto	— 1 Rixdollar
receives from		
Antwerp	104 Florins	— 100 Florins
Breslau	144 Rixdollars	— 100 Rixdollars
Venice	96 Soldi piccoli	— 1 Florin

*N. B.* The exchanges of Amsterdam are always transacted in *banco*, unless otherwise expressed.

### AUGSBURG.

#### *Monies of Exchange.*

Exchanges are computed in florins and creutzers, and also in rixdollars and creutzers.

60 Creutzers	= 1 Florin
1½ Florin or 90 creutzers	= 1 Rixdollar of account.

Two sorts of money are used here; *giro*, that is, money of exchange, and *currency*.

100 Florins of exchange = 127 Florins current.

#### *Quotation explained.*

Augsburg gives to	<i>Quotation explained.</i>	
	Uncertain prices.	Certain prices.
Amsterdam	{ 113 Rixdollars of } exchange	} for 100 Rixdollars
Hamburg	118 Ditto Ditto	— 100 Ditto
Francfort	102 Rixdollars cur.	— 100 Ditto
Leipfic	99 Ditto Ditto	— 100 Ditto
London	{ 10 Florins 45 } creutzers	— 1 Pound sterling
Paris	120 Florins current	— 300 Francs
Nuremberg	101 Florins Ditto	— 100 Florins
receives from		
Genoa	62 Soldifuoribanco	— 1 Florin
Leghorn	{ 57 Soldi moneta } buona	— 1 Ditto
Vienna	128 Florins	— 100 Ditto.

### BERLIN.

#### *Monies of Exchange.*

Exchanges are computed in rixdollars, good groschen, and pfenings *currency*.

12 Pfenings	= 1 Good grosche
24 Good groschen	= 1 Rixdollar of account.

#### *Quotation explained.*

Berlin gives to	<i>Quotation explained.</i>	
	Uncertain prices.	Certain prices.
Amsterdam	154 Rixdollars	for 100 Rixdollars
Breslau	100½ Ditto	— 100 Ditto
Hamburg	158 Ditto	— 100 Ditto
Konigsberg	100½ Ditto	— 100 Ditto
Francfort	105 Ditto	— 100 Ditto
Leipfic	104 Ditto	— 100 Ditto
London	{ 6½ Ditto 12 } groschen	— 1 Pound sterling.
Paris	83 Rixdollars	— 300 Francs
Augsburg	106 Ditto	— 100 Rixdollars
Vienna	60 Ditto	— 100 Ditto.

### BOLOGNA.

# EXCHANGE.

**BOLOGNA.** See **ROME.**

**BREMEN.**

*Monies of Exchange.*

Exchanges are computed in rixdollars, grotos, and swares  
 5 Swares = 1 Grote  
 72 Grotos = 1 Rixdollar of account.

*Quotation explained.*

Bremen gives to	Uncertain prices.	Certain prices.
Amsterdam	143 Rixdollars	for 100 Rixdollars
Hamburgh	142 Ditto	— 100 Ditto
Francfort	110 Ditto	— 100 Ditto
Leipsic	104 Ditto	— 100 Ditto
London	605 Ditto	— 100 Pounds sterling
Nuremberg	104 Ditto	— 100 Rixdollars
Paris	20 Grotos	— 1 Franc
Vienna	90 Rixdollars	— 100 Rixdollars.

**BRESLAU.** See **BERLIN.**

**CADIZ.**

*Monies of Exchange.*

Exchanges are computed in dollars, reals, and maravedis of old plate; also in ducats of exchange, and in doubloons of plate, or pistoles of exchange.

34 Maravedis = 1 Real  
 8 Reals = 1 Dollar of plate  
 375 Maravedis of plate = 1 Ducat of exchange  
 4 Dollars of plate = 1 Pistole of exchange.

*N. B.* Vellon, the current money of Spain, is to old plate as 17 to 32; that is,

32 Reals or maravedis vellon =  $\frac{1}{2}$  of 17 Reals or maravedis of old plate.

*Quotation explained.*

Cadiz gives to	Uncertain prices.	Certain prices.
Genoa	121 Dollars of plate	for 100 Pezze of 5 $\frac{3}{4}$ lire
Leghorn	130 Ditto	— 100 Pezze of 8 reals
Naples	{ 290 Maravedis of plate }	— 1 Ducat regno
receives from		
Amsterdam	97 Grotos Flemish	— 1 Ducat of exch.
London	42 Pence sterling	— 1 Dollar of plate
Paris	78 Sous tournois	— 1 Ditto
Hamburgh	90 Grotos Flemish	— 1 Ducat of exch.
Lisbon	2470 Rees	— 1 Dobloon of plate

**CONSTANTINOPLE.**

*Monies of Exchange.*

Exchanges are computed in piaftres, paras, and aspers; or in piaftres and aspers.

3 Aspers = 1 Para  
 40 Paras or 120 aspers = 1 Piaftre or dollar.

*Quotation explained.*

Constantinople gives to	Uncertain prices.	Certain prices.
London	17 Piaftres	for 1 Pound sterling
Vienna	50 Paras	— 1 Florin
Leghorn	145 Ditto	— 1 Pezza of 8 reals
Genoa	24 Ditto	— 1 Lira fuoribanco
Amsterdam	65 Ditto	— 1 Florin current

Constantinople gives to      Uncertain prices.      Certain prices.

Paris	200 Piaftres	for	300 Francs
Venice	360 Paras	—	{ 1 Sequin of 22 lire
receives from			
Marseilles	{ 1 Franc, 50 centimes }	—	1 Piaftre
Hamburgh	{ 25 Grotos Flemish }	—	1 Ditto
Smyrna	110 Piaftres	—	100 Ditto.

**COPENHAGEN.**

*Monies of Exchange.*

Exchanges are computed in rixdollars, marks, and skillings Danish; and sometimes in rixdollars, marks, and skillings lub or Hamburgh. Pfenings are also sometimes reckoned.

12 Pfenings = 1 Skilling  
 16 Skillings = 1 Mark  
 6 Marks Danish, or 3 marks lub = 1 Rixdollar  
 2 Marks or skillings Danish = 1 Mark or skilling lub.

*Quotation explained.*

Copenhagen gives to	Uncertain prices.	Certain prices.
Amsterdam	143 Rixdollars	for 100 Rixdollars
Hamburgh	149 Ditto	— 100 Ditto
London	{ 6 Rixdollars 30 shillings }	— 1 Pound sterling
Paris	25 Skillings Danish	— 1 Franc.

**DANTZIC.**

*Monies of Exchange.*

Exchanges are computed in florins, groschen, and pfenings.

18 Pfenings = 1 Grosche  
 30 Groschen = 1 Florin or gulden  
 3 Florins = 1 Rixdollar.

*Quotation explained.*

Dantzic gives to	Uncertain prices.	Certain prices.
Amsterdam	372 Groschen	for 1 Pound Flemish
Hamburgh	169 Ditto	— 1 Rixdollar specie
London	24 Florins	— 1 Pound sterling
Paris	110 Rixdollars	— 300 Francs
Francfort	105 Groschen	— 1 Rixdollar.
Leipsic	125 Rixdollars	— 100 Ditto.

**FLORENCE.** See **LEGHORN.**

**FRANCFORT.**

*Monies of Exchange.*

Exchanges are computed in florins and creutzers; or in rixdollars and creutzers; also in florins and batzen.

4 Creutzers = 1 Batze  
 60 Creutzers, or 15 batzen = 1 Florin or gulden  
 90 Creutzers, or 1 $\frac{1}{2}$  florin = 1 Rixdollar of account.

*Quotation explained.*

Francfort gives to	Uncertain prices.	Certain prices.
Amsterdam	140 Rixdollars	for 100 Rixdollars current
Hamburgh	150 Ditto	— 100 Ditto banco

Francfort

# EXCHANGE.

Francfort gives to	Uncertain prices.	Certain prices.
Augsburg	101 Rixdollars for	100 Rixdollars banco
Vienna	60 Florins —	100 Florins
France	79 Rixdollars —	300 Livres
Leipfic	100½ Ditto —	{ 100 Rixdollars in louis d'or
Bremen	108 Ditto —	100 Ditto
Bafil	101 Ditto —	100 Ditto in new ecus.

## GENEVA.

### *Monies of Exchange.*

Exchanges are computed in livres, fous, and deniers current; and in ecus, livres, &c.

12 Deniers	= 1 Sou or fol
20 Sous	= 1 Livre
3 Livres	= 1 Ecu.

### *Quotation explained.*

Geneva gives to	Uncertain prices.	Certain prices.
Hamburg	23 Sous for	1 Mark
Leghorn	104 Ecus —	100 Pezze of 8 reals
Genoa	95 Ditto —	100 Pezze of 5½ lire
Milan	98 Ditto —	640 Current lire
Spain	44 Sous —	1 Dollar of plate
receives from		
France	166 Francs —	100 Livres
London	49 Pence sterling —	1 Ecu
Amsterdam	89 Grotes Flemish —	1 Ditto
Augsburg	{ 127 Rixdollars } —	100 Ditto
	{ current }	
Bafil	168 Livres tournois —	100 Livres
Turin	84 Soldi —	1 Ecu.

## GENOA.

### *Monies of Exchange.*

Exchanges are computed in lire, soldi, and denari di lira; or in pezze, soldi, and denari di pezza; all in currency, called *fuori banco*.

12 Denari di lira	= 1 Soldi di lira
20 Soldi di lira	= 1 Lira
12 Denari di pezza	= 1 Soldo di pezza
20 Soldi di pezza	= 1 Pezza
5¼ Lire	= 1 Pezza
4 Lire 12 foldi	= { 1 Scudio di cambio, or crown of exchange
10 Lire 14 foldi	= { 1 Scudo d'oro marche, or gold crown.

### *Quotation explained.*

Geneva gives to	Uncertain prices.	Certain prices.
Leghorn	124 Soldi di lira for	1 Pezza of 8 reals
Rome	128 Ditto —	1 Roman crown
Naples	103 Ditto —	1 Ducat regno
Hamburg	45 Ditto —	1 Mark
Vienna	30 Ditto —	1 Florin
Augsburg	62 Ditto —	1 Ditto
receives from		
Venice	33 Soldi piccoli —	1 Lira
Palermo	36 Grani —	1 Ditto
Amsterdam	85 Grotes Flemish —	1 Pezza
France	94 Sous in francs —	1 Ditto

Genoa receives from	Uncertain prices.	Certain prices.
Spain	{ 620 Maravedis of } for	1 Gold crown
	{ plate }	
Lisbon	718 Rees —	1 Pezza
Milan	87 Soldi —	4 Lire
London	48 Pence sterling —	1 Pezza

## HAMBURGH.

### *Monies of Exchange.*

Exchanges are computed in marks, schilling lubs, and pfenings; or in pounds, shillings, and pence Flemish; also in rixdollars, marks, &c.

12 Pfenings	= 1 Schilling lubs
16 Schillings	= 1 Mark
3 Marks	= 1 Rixdollar
6 Pfenings	= 1 Grote or penny Flemish
12 Grotes	= 1 Shilling Flemish
20 Grotes Flemish	= 1 Pound Flemish
Thus, 6 Schilling lubs	= 1 Shilling Flemish
7½ Marks	= 1 Pound Flemish.

There are two sorts of money in Hamburg, called *banco* and *currency*. Banco bears an agio or premium against currency, which is generally from 20 to 25 per cent.

### *Quotation explained.*

Hamburg gives to	Uncertain prices.	Certain prices.
London	{ 33 Shillings 7 } for	1 Pound sterling
	{ Grotes Flem. }	
France	26 Schilling lubs —	3 Francs
Spain	91 Grotes Flemish —	1 Ducat of exch.
Portugal	43 Ditto —	1 Old crusade
Genoa	80 Ditto —	1 Pezza of 5½ lire
Leghorn	86 Ditto —	1 Pezza of 8 reals
Bafil	25 Schilling lubs —	1 Ecu of 3 francs
receives from		
Amsterdam	33 Stivers —	2 Marks
Breslau	139 Rixdollars —	100 Rixdollars
Copenhagen	149 Ditto —	100 Ditto
Vienna	310 Florins —	100 Ditto
Venice	82 Soldi piccoli —	1 Mark.

N. B. The exchanges of Hamburg are always transacted in banco, unless otherwise expressed.

## LEGHORN.

### *Monies of Exchange.*

Exchanges are computed in pezze, soldi, and denari di pezza; sometimes in lire, foldi, and denari di lira, moneta buona.

12 Denari di pezza	= 1 Soldo di pezza
20 Soldi di pezza	= 1 Pezza of 8 reals
12 Denari di lira	= 1 Soldo di lira
20 Soldi di lira	= 1 Lira
5¼ Lire, moneta buona	= 1 Pezza of 8 reals.

### *Quotation explained.*

Leghorn gives to	Uncertain prices.	Certain prices.
Vienna	{ 30 Soldi mone- } for	1 Florin
	{ ta buona }	
Novi	186 Pezze —	{ 100 Scudi d'oro marche.

Leghorn

# EXCHANGE.

Leghorn receives from		Uncertain prices.	Certain prices.
Rome	128	Bajocchi for	1 Pezza of 8 reals
Naples	118	Ducats regno	— 100 Ditto
Palermo	11	Tari 15 grani	— 1 Ditto
Genoa	125	Soldi fuori banco	— 1 Ditto
Milan	136	Soldi correnti	— 1 Ditto
Florence	124	Soldi	— 1 Ditto
Turin	93	Soldi	— 1 Ditto
Venice	10½	Lire piccole	— 1 Ditto
France	104	Sous in francs	— 1 Ditto
London	54	Pence sterling	— 1 Ditto
Amsterdam	95	Grotes Flemish	— 1 Ditto
Hamburgh	89	Grotes Flemish	— 1 Ditto
Lisbon	855	Rees	— 1 Ditto
Spain	140	Dollars of plate	— 100 Ditto
Augsburg	204	Florins current	— 100 Ditto
Bologna	96	Bolognini	— 1 Ditto
Ancona	132	Bajocchi	— 1 Ditto
Geneva	109	Ecus of 3 livres	— 100 Ditto
Petersburg	190	Rubles	— 100 Ditto.

LEIPSI. See BERLIN.

## LISBON.

### Monies of Exchange.

Exchanges are computed in rees and milrees, and also in old crusades.

1000 Rees = 1 Milree  
400 Rees = 1 Old crusade.

### Quotation explained.

Lisbon gives to	Uncertain prices.	Certain prices.
Paris	470 Rees	for 3 Francs
Genoa	746 Ditto	— 1 Pezza of 5¾ lire
Leghorn	810 Ditto	— 1 Pezza of 8 reals
Vienna	360 Ditto	— 1 Florin
Venice	66 Ditto	— 1 Lira piccola
Spain	2430 Ditto	— 1 Dobloon of plate
London	66 Pence sterling	— 1 Milree
Amsterdam	45 Grotes Flemish	— 1 Old crusade
Hamburgh	43 Ditto	— 1 Ditto.

## MADRID.

### Monies of Exchange. See CADIZ.

### Quotation of Madrid on Paris explained.

Madrid receives from	Uncertain price.	Certain price.
Paris	{ 15 Francs 40 centimes }	for 1 Dobloon of plate.

The other exchanges of Madrid are similar to those of Cadiz.

## MILAN.

### Monies of Exchange.

Exchanges are computed in lire, soldi, and denari correnti or imperiali.

12 Denari = 1 Soldo  
20 Soldi = 1 Lira  
106 Lire or soldi imperiali = 150 Lire or soldi correnti  
117 Soldi imperiali = 1 Scudo or crown.

### Quotation explained.

Milan gives to	Uncertain prices.	Certain prices.
France	55 Soldi imperiali	for 3 Francs
Genoa	86 Soldi correnti	— 4 Lire fuori banco
Rome	138 Ditto	— 1 Roman crown
Leghorn	135 Ditto	— 1 Pezza of 8 reals
Augsburg	66 Ditto	— 1 Florin current
Venice	84 Ditto	— 1 Ducat current
Vienna	55 Ditto	— 1 Florin current
Amsterdam	57 Ditto	— 1 Florin banco
London	31 Lire correnti	— 1 Pound sterling
Hamburgh	49 Soldi correnti	— 1 Mark.

## NAPLES.

### Monies of Exchange.

Exchanges are computed in ducats and grains, or in ducats, carlins, and grains.

10 Grains = 1 Carlin  
10 Carlins or 100 grains = 1 Ducat regno.

### Quotation explained.

Naples gives to	Uncertain prices.	Certain prices.
Leghorn	120 Ducats regno	for 100 Pezze
Amsterdam	54 Grains	— 1 Florin
Spain	85 Ditto	— 1 Dollar of plate
Rome	125 Ducats	— 100 Roman crowns
Hamburgh	45 Grains	— 1 Mark
Sicily	120 Ditto	— 1 Sicilian crown
London	42 Pence sterling	— 1 Ducat regno
Genoa	102 Soldi fuori banco	— 1 Ditto
Venice	{ 9 Lire 15 soldi piccoli }	— 1 Ditto
France	84 Sous in francs	— 1 Ditto
Lisbon	670 Rees	— 1 Ditto.

## PALERMO.

### Monies of Exchange.

Exchanges are computed in ounces, tari, and grains; and also in scudi, tari, and grains.

20 Grains = 1 Taro  
30 Tari = 1 Ounce  
12 Tari = 1 Scudo or crown;  
Thus 5 Crowns = 2 Ounces.

### Quotation explained.

Palermo gives to	Uncertain prices.	Certain prices.
Amsterdam	5½ Tari	for 1 Florin
Genoa	40 Grains	— 1 Lira fuori banco
Leghorn	12½ Tari	— 1 Pezza of 8 reals
Lisbon	6½ Tari	— 1 Old crusade
London	60 Tari	— 1 Pound sterling
Paris	50 Grains	— 1 Livre
Rome	12½ Tari	— 1 Roman crown
Spain	8½ Tari	— 1 Dollar of plate.
Naples	120 Grains	— 1 Sicilian crown.

## PARIS.

### Monies of Exchange.

Exchanges are computed in francs and centimes; or in livres, sous, and deniers tournois.

100 Centimes

# EXCHANGE.

100 Centimes	=	1 Franc
12 Deniers	=	1 Sou or fol
20 Sous	=	1 Livre
80 Francs	=	81 Livres
3 Livres or 3 francs	=	1 Ecu of exchange.

The 5 franc piece is also sometimes divided into 100 fous, which are distinguished by saying, 100, or so many fous in francs.

### Quotation explained.

Paris gives to	Uncertain prices.	Certain prices.
London	24 Francs	for 1 Pound sterling
Hamburgh	185 Francs	— 100 Marks
Genoa	465 Centimes	— 1 Pezza of 5½ lire
Leghorn	504 Centimes	— 1 Pezza of 8 reals
Spain	15 Francs 40 cent.	— 1 Dobloon of plate
Geneva	162 Francs	— 100 Livres current
Basil	101 Livres	— 100 Livres
Augsburg	249 Centimes	— 1 Florin current
Vienna	160 Centimes	— 1 Florin
Naples	4 Francs 20 cent.	— 1 Ducat regno
receives from		
Amsterdam	54 Grotes Flemish	— 3 Francs
Frankfort	75 Rixdollars cur.	— 300 Ditto
Lisbon	460 Rees	— 3 Ditto
Milan	8 Livres 6 foldi	— 6 Ditto.

### PETERSBURGH.

#### Monies of Exchange.

Exchanges are computed in rubles and copecks.

100 Copecks = 1 Ruble.

### Quotation explained.

Petersburgh gives to	Uncertain prices.	Certain prices.
Constantinople	50 Copecks	for 1 Piafre.
London	28 Pence sterling	— 1 Ruble
Amsterdam	25 Stivers	— 1 Ditto
Vienna	125 Creutzers	— 1 Ditto
Leipfic	17 Groschen	— 1 Ditto
Paris	270 Centimes	— 1 Ditto

### ROME.

#### Monies of Exchange.

Exchanges are computed in scudi moneta, and bajocchi; or in scudi di stampa d'oro, foldi and denari d'oro; quattrini and mezzi quattrini are also sometimes reckoned.

2 Mezzi quattrini	=	1 Quattrino
5 Quattrini	=	1 Bajocco or Bolognino
100 Bajocchi	=	{ 1 Scudo moneta, or Roman crown
1523 Mezzi quattrini, or 1523 <sup>3</sup> / <sub>10</sub> bajocchi	=	{ 1 Scudo di stampa d'oro, or gold crown
12 Denari d'oro	=	1 Soldo d'oro
20 Soldi d'oro	=	1 Gold crown.

### Quotation explained.

Rome gives to	Uncertain prices.	Certain prices.
Florence	84 Gold crowns	for 100 Gold crowns
Milan	81 Roman crowns	— 100 Scudi imperiali
Ancona	99 Ditto	— 100 Crowns
Bologna	98 Ditto	— 100 Ditto
Leghorn	98 Bajocchi	— 1 Pezza of 8 reals
Amsterdam	44 Ditto	— 1 Florin

Rome receives from	Certain prices.	Uncertain prices.
Naples	122 Ducats regno	for 100 Roman crowns
Venice	11 Lire 10 foldi piccoli	— 1 Ditto
Genoa	124 Soldi fuori banco	— 1 Ditto
Paris	105 Sous in francs	— 1 Ditto
London	51 Pence sterling	— 1 Ditto

### ROTTERDAM.

#### Monies of Exchange. See AMSTERDAM.

#### Quotation on London explained.

Rotterdam gives to	Uncertain price.	Certain price.
London	11 Florence current	for 1 Pound sterling.

For the other exchanges of Rotterdam, see AMSTERDAM.

### STOCKHOLM.

#### Monies of Exchange.

Exchanges are computed in rixdollars, skillings, and fenings.

12 Fenings or Oers	=	1 Skilling
48 Skillings	=	1 Rixdollar.

### Quotation explained.

Stockholm gives to	Uncertain prices.	Certain prices.
Amsterdam	44 Skillings	for 1 Rixdollar
Copenhagen	36 Ditto	— 1 Ditto
Dantzic	9½ Ditto	— 1 Florin
Hamburgh	47 Ditto	— 1 Rixdollar
Leghorn	40 Ditto	— 1 Pezza of 8 reals
London	4½ Rixdollars	— 1 Pound sterling
Paris	24 Skillings	— 1 Ecu of 3 livres
Spain	42 Ditto	— 1 Ducat of exch.

### TRIESTE. See VIENNA.

### TURIN.

#### Monies of Exchange.

Exchanges are computed in lire, foldi, and denari.

12 Denari	=	1 Soldo
20 Soldi	=	1 Lira

### Quotation explained.

Turin gives to	Uncertain prices.	Certain prices.
Amsterdam	37 Soldi	for 1 Florin
Augsburg	42 Ditto	— 1 Ditto
Geneva	82 Ditto	— 3 Livres
Genoa	9 Lire 8 foldi	— 1 Sequin
Leghorn	86 Soldi	— 1 Pezza of 8 reals
London	19 Lire 10 foldi	— 1 Pound sterling
Milan	92 Soldi	— 7½ Lire correnti
Paris	20 Lire	— 24 Francs
Rome	87 Soldi	— 1 Roman crown
Venice	94 Ditto	— 1 Ducat current.

### VENICE.

#### Monies of Exchange.

Exchanges are computed in lire, foldi, and denari, moneta piccola; and also in ducats.

12 Denari	=	1 Soldo
20 Soldi	=	1 Lira
6 Lire 4 foldi	=	1 Ducat current, or of account
8 Lire	=	1 Ducat effective

*Quotation*

# EXCHANGE.

## Quotation explained.

Venice gives to	Uncertain prices.	Certain prices.
London	56 Lire piccole	for 1 Pound sterling
Amsterdam	4 Lire 18 foldi ditto	— 1 Florin
Augsburg	4 Lire 16 foldi ditto	— 1 Ditto
Constantinople	3 Lire 6 foldi	— 1 Piaſtre
Paris	2 Lire 5 foldi	— 1 Franc
Genoa	38 Soldi	— 1 Lira fuori banco
Hamburgh	4 Lire 6 foldi	— 1 Mark
Leghorn	11 Lire 18 foldi	— 1 Pezza
Milan	34 Soldi	— 1 Lira corrente
Naples	9 Lire 18 foldi	— 1 Ducat regno
Vienna	4 Lire 8 foldi	— 1 Florin
Rome	12 Lire 10 foldi	— 1 Roman crown.

## VIENNA.

### Monies of Exchange.

Exchanges are computed in florins and creutzers, or in rixdollars and creutzers; pfenings are sometimes used.

4 Pfenings	= 1 Creutzer
60 Creutzers	= 1 Florin
90 Creutzers, or 1½ florin	= 1 Rixdollar of account.

### Quotation explained.

Vienna gives to	Uncertain prices.	Certain prices.
Amsterdam	286 Rixdollars for 100	Rixdollars current
Augsburg	202½ Ditto	— 100 Ditto
Hamburgh	300 Ditto	— 100 Ditto banco
London	19 Florins	— 1 Pound sterling
Paris	47 Creutzers	— 1 Franc
Constantinople	112 Florins	— 1 Piaſtre
Venice	184 Ditto	— 500 Lire piccole
Prague	99½ Ditto	— 100 Florins
receives from		
Genoa	30 Soldi fuori banco	for 1 Florin
Leghorn	28 Soldi moneta buona	— 1 Ditto
Milan	33 Soldi correnti	— 1 Ditto.

## AMERICA.

### Monies of Exchange.

Exchanges are computed in dollars, dimes, and cents; and in some places in pounds, shillings, and pence currency.

10 Cents	= 1 Dime
10 Dimes, or 100 cents	= 1 Dollar,
12 Pence currency	= 1 Shilling ditto
20 Shillings currency	= 1 Pound ditto.

### American Quotations explained.

New York gives to	Uncertain prices.	Certain prices.
London	177 Pounds currency for	1 Pound sterling
Amsterdam	42 Cents	— 1 Guilder
Hamburgh	35 Cents	— 1 Mark
Bremen	78 Cents	— 1 Rixdollar
receives from		
Paris	5 Francs 30 cent.	— 1 Dollar.
Philadelphia gives to		
Amsterdam	43 Cents	for 1 Guilder
Hamburgh	35 Cents	— 1 Mark
receives from		
London	4s. 6d. sterling at par	— 1 Dollar

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Baltimore gives to

	Uncertain prices.	Certain prices.
Amsterdam	40 Cents	for 1 Guilder
Hamburgh	33 Cents	— 1 Mark
London	101 Cents	— 4s. 6d. sterling.

These American quotations have been copied from a New York paper of March 1809. All the other quotations may be likewise relied on, having been taken from genuine and recent authorities.

## LONDON.

### Monies of Exchange.

Exchanges are computed in pounds, shillings, and pence sterling; and farthings are sometimes reckoned.

4 Farthings	= 1 Penny
12 Pence	= 1 Shilling
20 Shillings	= 1 Pound.

### Lloyd's List explained.

London gives to	Uncertain prices.	Certain prices.
Madrid	42 Pence sterling for	1 Dollar of plate
Genoa	47½ Ditto	— 1 Pezza of 5¼ lire
Leghorn	51½ Ditto	— 1 Pezza of 8 reals
Lisbon	68 Ditto	— 1 Milree
Naples	42 Ditto	— 1 Ducat regno
Palermo	90 Ditto	— 1 Ounce
receives from		
Amsterdam	34 Shillings Flem.	— 1 Pound sterling
Rotterdam	11 Florins current	— 1 Ditto
Hamburgh	33 Shillings Flem.	— 1 Ditto
Paris	23 Livres 10 fous	— 1 Ditto
Venice	52 Lire piccole	— 1 Ditto
Dublin	{ 10 per cent, that is, 11% Irish }	— 100 Ditto.

Examples for calculating the exchanges of London with the above places are here given; whence the method of computing the exchanges of other places one with another may be easily comprehended, as all operations of this kind may be performed by the Rule of Three Direct.

## LONDON and AMSTERDAM.

English money is reduced to Dutch by saying; as 1l. sterling is to the rate of exchange, so is the given sum to the sum sought.

Reduce 782l. 12s. 6d. sterling to Dutch money, exchange at 34 shillings and 8 pence Flemish per pound sterling.

As	£.	s.	d.	Flem.	::	£.	s.	d.	Flor. Stiv.
	1	:	34	8	::	782	12	6	: 8139 6
				12				20	
				416				35652	
				8				12	
				3328	Pennings			187830	
								3328	
								1502640	
								375660	
								563490	
								563490	16
	24,0			62509824,0	(2604576			Pennings	
				48					
								2,0	16278,6
				145, &c.					Stivers
									8139 Flor. 6 Stiv.
									Dutch

4 N

## EXCHANGE.

Dutch money is reduced to English by reverſing the foregoing operation; thus,

<i>s. d.</i>	<i>£.</i>	Flor. Stiv.	<i>£. s. d.</i>
As 34 8 Flem. :	1 :	8139 6 :	782 12 6

### LONDON and HAMBURGH.

English money is reduced to that of Hamburg by an operation ſimilar to the foregoing.

Reduce 106*l.* 17*s.* 6. ſterling to Hamburg money; exchange at 35 ſhillings 4 grotes Flemiſh *per* pound ſterling.

<i>£. s. d.</i>	<i>£.</i>	<i>s. d.</i>	<i>M. Sc. Pf.</i>
As 1 :	35 4 :	106 17 6 :	1416 1 6
<u>12</u>	<u>20</u>		
424	2137		
<u>6</u>	<u>12</u>		
2544 Pfenings	25650		
<u>2544</u>	<u>2544</u>		

102600	
102600	
128250	
51300	12
<u>24,0)6525360,0</u>	<u>(271890 Pfenings</u>
48	
172, &c.	16)22657 Schill. 6 Pfen.
<u>1416 M. 1 Sc. 6 Pf.</u>	

Hamburg money is reduced to English by reverſing the foregoing operation; thus,

<i>s. d.</i>	<i>£.</i>	<i>M. Sc. Pf.</i>	<i>£. s. d.</i>
As 35 4 Flem. :	1 :	1416 1 6 :	106 17 6

### LONDON and PARIS.

English money is reduced to French by ſaying; as 1*l.* is to the rate of exchange, ſo is the given ſum to the ſum fought.

Reduce 728*l.* 15*s.* ſterling to French money, exchange at 23 livres 10 ſous *per* pound ſterling.

<i>£.</i>	<i>Liv. So.</i>	<i>£. s.</i>	<i>Liv. So. Den.</i>
As 1 :	23 10 :	728 15 :	17125 12 6
<u>20</u>	<u>20 × 470</u>		
470	2,0)685025,0		

<u>2,0)34251,2½</u>	<u>Sous</u>
<u>17125</u>	<u>Liv. 12 Sous, 6 Den.</u>

But if the answer be required in francs, the livres muſt be multiplied by 80 and divided by 81; thus,

<i>Liv. So. Den.</i>	<i>Francs: Cen.</i>
As, 81 :	80 :: 17125 12 6 :
<u>17125 12 6</u>	<u>16914 19</u>

French money is reduced to English by reverſing the foregoing operation; thus,

<i>Francs. Cen.</i>	<i>Liv. So. Den.</i>
As 80 :	81 :: 16914 19 :
<u>16914 19</u>	<u>17125 12 6</u>

And as 23 10 : 1 :: 17125 12 6 : 728 15

The exchange of Paris on London is, however, generally expreſſed in francs, and then the reduction may be performed by a ſingle analogy; thus,

Reduce 4305 francs 95 centimes to ſterling; exchange at 24 francs 25 centimes *per* pound ſterling.

<i>Fr. Cen.</i>	<i>£.</i>	<i>Fr. Cen.</i>	<i>£. s. d.</i>
As 24 25 :	1 ::	4305 95 :	177 11 3½

### LONDON and SPAIN.

English money is reduced to Spanish by ſaying; as the rate of exchange is to 1 dollar, ſo is the given ſum to the ſum fought.

Reduce 391*l.* 1*s.* 3*d.* ſterling to Spanish money, exchange at 35½ ſterling *per* dollar of plate.

<i>d.</i>	<i>Doll.</i>	<i>£. s. d.</i>	<i>Doll. R. M.</i>
As 35½ :	1 ::	391 1 3 :	2643 6 14
<u>2</u>	<u>8</u>	<u>× 20 × 12 × 2</u>	
71	8	187710	
<u>—</u>	<u>34</u>	<u>× 272</u>	
<u>272 Ma. 71)51057120</u>	<u>(719114</u>	<u>Maravedis.</u>	

8)21150 Reals 14 Mar.

2643 Doll. 6 R. 14 M.

But if the answer be required in vellon, the reals of plate ſhould be multiplied by 32 and divided by 17; thus,

<i>Reals. Mar. plate.</i>	<i>Reals. Mar. vell.</i>
As 17 : 32 ::	21150 14 : 39812 18

Spanish money is reduced to English by reverſing the foregoing operation; thus,

<i>Doll.</i>	<i>d.</i>	<i>Doll. R. Mar.</i>	<i>£. s. d.</i>
As 1 :	35½ ::	2643 6 14 :	391 1 3

### LONDON and LEGHORN.

English money is reduced to that of Leghorn by ſaying; as the rate of exchange is to 1 pezza, ſo is the given ſum to the ſum fought.

Reduce 392*l.* 18*s.* 4¼*d.* ſterling to money of Leghorn; exchange at 50¼*d.* *per* pezza of 8 reals.

<i>d.</i>	<i>Pezza.</i>	<i>£. s. d.</i>	<i>Pezza Sol. De.</i>
As 50¼ :	1 ::	392 18 4¼ :	1876 12 5
<u>4</u>	<u>× 20 × 12 × 4</u>		
201	201)377201	(1876 Pez. 12 Sol. 5 Den.	
<u>201</u>	<u>201</u>	<u>&amp;c.</u>	

Money of Leghorn is reduced to English by reverſing the foregoing operation; thus,

<i>Pezza</i>	<i>d.</i>	<i>Pezza Sol. Den.</i>	<i>£. s. d.</i>
As 1 :	50¼ ::	1876 12 5 :	392 18 4¼

### LONDON and GENOA.

English money is reduced to money of Genoa by an analogy ſimilar to the foregoing.

Reduce 239*l.* 11*s.* 3*d.* to money of Genoa; exchange at 45*d.* ſterling *per* pezza of 5¼ lire fuori banco.

<i>d.</i>	<i>Pezza</i>	<i>£. s. d.</i>	<i>Pezza Sol. Den.</i>
As 45 :	1 ::	239 11 3 :	1277 13 4
<u>—</u>	<u>× 20 × 12</u>		

45)57495(1277 Pezze 13 Soldi 4 Den.

45  
124, &c.

But

# E X C H A N G E.

But if the answer be required in lire, the sum thus found should be multiplied by 23, and divided by 4; thus,

Pez. Sol. D. di Pez. Lire Sol. D. di Lira  
As 4 : 23 :: 1277 13 4 : 7346 11 8

Money of Genoa is reduced to English by reverfing the foregoing operation; thus

Lire Sol. D. di Lira Pez. Sol. D. di Pez.  
As 23 : 4 :: 7346 11 8 : 1277 13 4

Pezza d. Pezze Sol. Den. £. s. d.  
And as 1 : 50 $\frac{1}{2}$  :: 1277 13 4 : 239 11 3

## LONDON and LISBON.

English money is reduced to Portuguese by faying; as the rate of exchange is to 1 milree, fo is the given fum to the fum fought.

Reduce 218*l.* 8*s.* 5 $\frac{1}{2}$ *d.* to Portugal money; exchange at 63 $\frac{1}{2}$ *d.* sterling *per* milree.

d. Milree £. s. d. Mil. Rees  
As 63 $\frac{1}{2}$  : 1 :: 218 8 5 $\frac{1}{2}$  : 827 160  
8 × 20 × 12 × 8

507 507)419370(827,160  
4056

&c.

Portugal money is reduced to English by reverfing the foregoing operation; thus,

Milree d. Mil. Rees £. s. d.  
As 1 : 63 $\frac{1}{2}$  :: 827 160 : 218 8 5 $\frac{1}{2}$

## LONDON and NAPLES.

English money is reduced to that of Naples by faying; as the rate of exchange is to 1 ducat, fo is the given fum to the fum fought.

Reduce 158*l.* 9*s.* 3*d.* to money of Naples; exchange at 37 $\frac{1}{2}$ *d.* sterling *per* ducat regno.

d. Ducat £. s. d. Ducats Grains  
As 37 $\frac{1}{2}$  : 1 :: 158 9 3 : 1014 16  
2 × 20 × 12 × 2

75 75)76062(1014,16  
75

&c.

Money of Naples is reduced to sterling by reverfing the foregoing operation; thus,

Ducat d. Ducats Grains £. s. d.  
As 1 : 37 $\frac{1}{2}$  :: 1014 16 : 158 9 3

## LONDON and PALERMO.

English money is reduced to Sicilian by faying; as the rate of exchange is to 1 ounce, fo is the given fum to the fum fought.

Reduce 565*l.* 10*s.* 9*d.* sterling to Sicilian money; exchange at 89*d.* sterling *per* ounce.

d. Oz. £. s. d. Oz. Taro Grs.  
As 89 : 1 :: 565 10 9 : 1525 1 7  
× 20 × 12

89)135729(1525 Oz. 1 taro 7 grains.  
89

&c.

Remainder 4 oz. × 30 × 20 ÷ 89 gives 1 taro 7 grains.

Sicilian money is reduced to English by reverfing the foregoing operation; thus:

Oz. d. Oz. Taro Grs. £. s. d.  
As 1 : 89 :: 1525 1 7 : 565 10 9

## LONDON and VENICE.

English money is reduced to Venetian by faying; as 1*l.* is to the rate of exchange, fo is the given fum to the fum fought.

Reduce 250*l.* 11*s.* 3*d.* to Venetian money; exchange at 59 lire piccole *per* pound sterling.

£. Lire £. s. d. Lire Sol. Den.  
As 1 : 59 :: 250 11 3 : 14783 3 9  
× 20 × 12 × 59

24,0)354796,5(14783 Lire 3 Soldi 9 Denari.  
24

&c.

Venetian money is reduced to English by reverfing the foregoing operation; thus,

Lire £. Lire Sol. Den. £. s. d.  
As 59 : 1 :: 14783 3 9 : 250 11 3

## LONDON and ROTTERDAM.

English money is reduced to Dutch currency by faying; as 1*l.* is to the rate of exchange, fo is the given fum to the fum fought.

Reduce 196*l.* 17*s.* 6*d.* sterling to Dutch currency in Rotterdam; exchange at 12 florins 4 stivers *per* pound sterling.

£. Fl. St. £. s. d. Fl. St. Pen.  
As 1 : 12 4 :: 196 17 6 : 2401 17 8  
20 × 20 × 12 × 244

244 24,0)1152900,0(4803,7 $\frac{1}{2}$  Stivers.  
96

2401 Florins 17 $\frac{1}{2}$  Stivers.

&c.

Dutch currency is reduced to English money by reverfing the foregoing operation; thus,

Fl. St. £. Flor. St. Pen. £. s. d.  
As 12 4 : 1 :: 2401 17 8 : 196 17 6

## LONDON and DUBLIN.

English money is reduced to Irish by faying; as 100 is to 100 more the rate of exchange, fo is the given fum to the fum fought.

Reduce 787*l.* 15*s.* English to Irish money; exchange at 11 $\frac{1}{2}$ .

As 100 : 111 $\frac{1}{2}$  :: 787 15 Eng. : 879 6 6 Ir.  
8 8 × 893

800 893 8,00)7034,60(15*s.*  
879

Rem. 2,60  
20

8,00)52,15(6,51  
12

6,12

# EXCHANGE.

*Or thus:*

	787	15	
		11	<sup>5</sup> / <sub>8</sub>
<hr/>			
	866	5	
4 =		393	17 6
11 =		98	9 4 <sup>1</sup> / <sub>2</sub>
<hr/>			
	91	57	12 10
		20	
		11	52
		12	
		6	35
<hr/>			
	£	787	15s. od.
		91	11 6
		879	6 6

Irish money is reduced to English by reverting the foregoing analogy; thus,

As 111 <sup>5</sup>/<sub>8</sub> : 100 :: £. s. d. 879 6 6 Ir : £. s. 787 15 Eng.

When the exchange between the two countries is at par, English money is turned to Irish by adding  $\frac{1}{12}$ , and Irish to English by subtracting  $\frac{1}{12}$ .

Thus reduce 787l. 15s. English to Irish money at par.

12)787	15	0	English
	55	12	11
13)853	7	11	Irish
	65	12	11
	787	15	0 English.

### Arbitration of Exchange.

Arbitration of exchange is a comparison between the courses of exchange of several places in order to ascertain the most advantageous method of drawing or remitting bills. It is distinguished into simple and compound arbitration; the former comprehends the exchanges of three places only, and the latter of more than three places.

#### Simple Arbitration

It is a comparison between the exchanges of two places with respect to a third; that is to say, it is a method of finding such a rate of exchange between two places, as shall be in proportion with the rates quoted between each of them and a third place. The exchange thus determined, is called the *arbitrated price*, and also *proportional exchange*; and the *proportional par*.

If, for example, the course between London and Paris be 24 francs for 1l. sterling, and between Paris and Amsterdam 54d. Flemish for 3 francs, (that is, 36s. Flemish for 24 francs,) the arbitrated price between London and Amsterdam, through Paris, is evidently 36s. Flemish for 1l. sterling: for as 3 fr. : 54d. Flem. :: 24 fr. : 36s. Flem.

Now when the actual direct price (as seen by a quotation or otherwise advised,) is found to differ from the arbitrated price, advantage may be made by drawing or remitting indirectly, that is, by drawing on one place through another, as on Amsterdam through Paris; which may be performed in three different ways.

1st. London may draw on Paris, and order his correspondent there to draw on Amsterdam.

2d. London may draw on Paris, and order his correspondent in Amsterdam to remit the same sum to Paris.

3d. London may order his correspondent at Paris to draw on Amsterdam, and to remit the value to London.

The operation of remitting indirectly, or of remitting to one place through another, may be likewise performed in three different ways:

1st. London may remit to Paris, and order his correspondent there to remit the sum to Amsterdam.

2d. London may remit to Paris, and order his correspondent in Amsterdam to draw on Paris.

3d. London may take bills on Paris, and remit them to Amsterdam, there to be negotiated.

To exemplify this by familiar illustrations, suppose the arbitrated price between London and Amsterdam to be as before stated, 36s. Flemish for 1l. sterling; and suppose the direct course, as given in Lloyd's list, to be 37s. Flemish, then London, by drawing directly on Amsterdam, must give 37s. Flemish for 1l. sterling; whereas, by drawing through Paris, he will give only 36s. Flemish for 1l. sterling: it is therefore the interest of London to draw indirectly on Amsterdam through Paris.

On the contrary, if London remits directly to Amsterdam, he will receive 37s. Flemish for 1l. sterling; whereas, by remitting through Paris, he will receive only 36s. Flemish: it is the interest of London therefore to remit directly to Amsterdam.

*Example 2.*—Suppose the exchange of London on Lisbon to be at 68d. per milree, and that of Lisbon on Madrid 500 rees per dollar, the arbitrated price between London and Madrid is 34d. st. per dollar; for as 1000 rees : 68d. :: 500 rees : 34d. But if the direct exchange of London on Madrid be 35d. sterling per dollar, then London, by remitting directly to Madrid, must pay 35d. for every dollar; whereas by remitting through Lisbon he will pay only 34d.: it is therefore the interest of London to remit indirectly to Madrid through Lisbon.

On the contrary, if London draws directly on Madrid, he will receive 35d. sterling per dollar; whereas, by drawing indirectly through Lisbon, he would receive only 34d.: it is therefore the interest of London to draw directly on Madrid.

From these examples, the two following rules are manifest.

*Rule 1.*—Where London gives the certain price, draw through that place which gives the lowest arbitrated price, and remit through that which produces the highest.

*Rule 2.*—Where London gives the uncertain price, draw through that place which produces the highest arbitrated price, and remit through that which gives the lowest.

What is said here of London will equally apply to any other place from whence the operation is made.

Suppose the exchange of London on Amsterdam to be 34.6; on Genoa, 47; on Leghorn, 52; and the exchange of Amsterdam on Genoa, 86; on Leghorn, 93; what is the most advantageous method for London to remit to, or draw on Amsterdam?

1st.—Because 47d. st. give 1 pezza in Genoa, and this pezza in Amsterdam gives 86d. Flemish, say, as 47d. st. : 86d. Flemish :: 240d. st. : 439d. Flemish, or 36s. 7d. Flemish, which is the arbitrated price through Genoa.

2d.—Because 52d. st. give 1 pezza in Leghorn, and this pezza in Amsterdam gives 93d. Flemish, say, as 52d. st. : 93d. Flemish :: 240d. st. : 429d. Flemish, or 35s. 9d. Flemish, which is the arbitrated price through Leghorn.

Hence, according to the first rule, the interest of London is to draw directly on Amsterdam, instead of drawing through Genoa or Leghorn; and to remit through Genoa, instead of remitting directly to Amsterdam, or indirectly through Leghorn.

And according to the second rule, the interest of Amsterdam would be to remit directly to London, and to draw on London through Genoa.

*Compound*

# EXCHANGE.

## Compound Arbitration:

Is a comparison between the exchanges of more than three places in order to find how much a remittance passing through them all will amount to at the last place, or to find the arbitrated price between the first place and the last, and thus to determine on the most advantageous mode of negotiating bills.

Compound arbitration is therefore a repetition of simple arbitration, and may be solved by a continuation of several statings in the Rule of Three; but all such operations are best performed by conjoint proportion; commonly called the "Chain rule," which shall be here explained and demonstrated, after giving an example of compound arbitration by the Rule of Three.

Suppose the exchange between London and Amsterdam to be 35 shillings Flemish for 1 l. sterling; between Amsterdam and Lisbon, 42 pence Flemish for 1 old crusade; and between Lisbon and Paris, 480 rees for three francs, what is the arbitrated exchange between London and Paris?

1st. As 35s. Flem. : 1 l. :: 42d. Flem., or 3½s. Flem. : 2s. ft. = 1 old crusade.  
 2dly. As 1 old crusade, or 400 rees : 2s. ft. :: 480 rees : 2s. 4¾d. ft. = 3 francs.  
 3dly. As 2s. 4¾d. ft. : 3 francs :: 240d. ft. : 25 francs.  
 Hence the arbitrated price is 25 francs for 1 l. sterling.

### The Chain Rule explained and demonstrated.

Distinguish the several courses of exchange into antecedents and consequents, and place them in two columns, the antecedents to the left and the consequents to the right, by way of equation.

The first antecedent must be of the same denomination as the quantity of which the value is required.

The first consequent must be of the same denomination as the second antecedent, and the second consequent as the third antecedent; and so on throughout.

The last consequent must be of that denomination in which the answer is required.

The terms being thus arranged, the antecedents must be multiplied continually for a divisor, and the consequents for a dividend; and the quotient will be the answer.

The calculation may be abridged by expunging such antecedents and consequents as are alike, and reducing such their lowest terms as admit of a common divisor.

### Example from the foregoing Question.

1 l. Sterling = 35 Shillings Flemish.  
 3½ Shillings Flemish = 400 Rees  
 480 Rees = 3 Francs.  
 How many francs will 1 l. sterling give?

$$\frac{3 \times 400 \times 35}{1 \times 480 \times 3\frac{1}{2}} = \frac{42000}{1680} = 25 \text{ francs.}$$

In this example, 480 and 400 have the common divisors 8 and 10, and they may therefore be reduced to 5 and 6; again the antecedent 6 may be reduced to 2, by striking out the first consequent 3; the fraction is therefore reduced

$$\text{to } \frac{5 \times 35}{2 \times 3\frac{1}{2}} = \frac{175}{7} = 25, \text{ as before.}$$

### Demonstration of the Chain Rule.

Let A, B, C, D, &c. be several denominations of money, and m, n, p, q, &c. the numbers or quantities of those denominations, and let them stand thus:

Antecedents.	=	:	:	Consequents.
m A . . .	=	:	:	n B
p B . . .	=	:	:	q C
r C . . .	=	:	:	s D
t D . . .	=	:	:	v E

Now to find what number of the last denomination (E) is equal to a given number of the first denomination (A) let z times the last term = y times the first, that is, let z E = y A.

Multiply all these equations together, the antecedents by the antecedents, and the consequents by the consequents, which will give m A × p B × r C × t D × z E = n B × q C × s D × v E × y A, and this equation reduced is m p r t z = n q s v y.

Now if the number of the last denomination be required, z =  $\frac{n q s v y}{m p r t}$ ; but if the number of the first denomination

be required, y =  $\frac{m p r t z}{n q s v}$ . Q. E. D.

Example 2.—If London remit 1000 l. sterling to Cadiz by way of Holland at 35 s. Flemish per pound sterling; thence to France at 58 d. Flemish per ecu of 3 francs; and thence to Cadiz at 15½ francs per doubloon of 4 dollars, what is the price between London and Cadiz resulting from the operation? and how many dollars will the 1000 l. amount to in Spain?

1 Pound sterling	=	35 Shillings Flemish
1 Shilling Flemish	=	12 Pence Flemish
58 Pence Flemish	=	3 Francs
15½ Francs	=	1 Doubloon
1 Doubloon	=	4 Dollars

How many dollars are equal to 1000 l. sterling?

$$\frac{35 \times 12 \times 3 \times 4 \times 1000}{58 \times 15\frac{1}{2}} = \frac{5040000}{899} = 5606 \text{ dollars, 1 real,}$$

28 mar. which gives the exchange at 42¾ d. nearly.

The indirect course of exchange between London and Cadiz may be also found by an inverse operation, called the *Doctrine of Contraries*: thus,

4 Dollars	=	1 Doubloon
1 Doubloon	=	15½ Francs
3 Francs	=	58 Pence Flemish
12 Pence Flemish	=	1 Shilling Flemish
35 Shillings Flemish	=	240 Pence sterling.

How many pence sterling equal 1 dollar?

$$\frac{240 \times 58 \times 15\frac{1}{2}}{4 \times 3 \times 12 \times 35} = \frac{58 \times 15\frac{1}{2}}{3 \times 7} = \frac{899}{21} = 42\frac{1}{2} d.$$

Now if the direct course of exchange was above the indirect, the circular remittance would be most advantageous; but if under, the direct operation would be preferable.

In computing the profits or losses of exchange operations, allowance should be made for the expences, commission, and interest of money, all of which may be comprised in the statement by the Chain Rule; that is, by deducting them from those terms of the consequents to which they may relate; thus, in the following example, the *per centage* is subtracted from 100 in the last place of the consequents.

Example 3.—London takes bills on Madrid at 33½ d. per dollar of exchange, remits them to Amsterdam, with orders to negotiate at 90½ grotes per ducat of exchange, and make the returns in bills on Paris at 51½ grotes per ecu of 3 francs: what does London gain or lose per cent. by this operation, supposing the bills on Paris are negotiated at 25 livres 18 sous per pound sterling; and that all the charges, including interest for the time that London is out of its money, amount to 1½ per cent.?

$$33\frac{1}{2} \text{ Pence sterling} = 272 \text{ Maravedis}$$

$$125 \quad 278 \text{ Maravedis} = 90\frac{1}{4} \text{ Grotes}$$

## EXCHANGE.

51½ Grotes = 2 Francs  
 4 \$5 Francs = 81 Livres  
 1 Livre = 20 Sous  
 259 51½ Sous = 440 Pence sterling 120  
 100 Pence sterling = 98½ On account of charges.  
 How much does 100*l.* sterling give?

$$\frac{272 \times 90\frac{1}{2} \times 81 \times 99\frac{1}{2}}{33\frac{1}{2} \times 125 \times 51\frac{1}{2} \times 4 \times 259 \times 100} = 105,853, \text{ answer.}$$

The profit is therefore *5l. 17s. 0½d. per 100*l.* sterling.*

Operations in compound arbitration may be greatly facilitated by the help of logarithms: thus, "from the sum of the logarithms of the consequents, subtract the sum of the logarithms of the antecedents; the difference will be the logarithm of the answer."

In this case, however, the reduction of the numbers as above is superfluous, as it is as easy to find the logarithm of a large as of a small number; but when equal terms are on both sides they should be struck out; and if a common divisor can be found which will reduce any term to unity, it will likewise shorten the operation.

In questions of this kind much time and labour may be sometimes saved by making use of *fixed numbers*; thus, where several terms are unchangeable in both the antecedents and consequents they can be reduced to one; and the constant logarithm of this number may be used with those that vary; such as the logarithms of the rate of exchange, the amount of the charges, &c.

Besides the foregoing rules for facilitating the arbitration of exchange, various other methods have been proposed for shortening and illustrating the subject; even triangles and other diagrams have been constructed for this purpose; (see Postlethwait's Commercial Dictionary, vol. i. p. 94.) but geometrical projections do not seem well adapted to elucidate this rule.

A graphic operation, however, of a very useful and ingenious description, has been lately executed in London, in which scales of the monies of exchange of the principal places in Lloyd's list are so graduated and arranged, that the arbitrated price between any two of them, with respect to a third place, may be immediately found by the application of a right line. The invention is by William Wollaston, M.D. S. and F.R.S.

We shall conclude this article by giving rules for calculating the intrinsic par of exchange, and also tables of the same in gold and silver according both to mint regulations, and to assays.

The intrinsic par of exchange may be calculated by the rules laid down for computing the value of coins. (See COIN.) But the operation may be performed with greater precision by the Chain rule, as in the following examples.

*Example 1.*—What is the intrinsic par between London and Lisbon, in *gold*, when taken from the Johanes of 6400 rees, which, according to the mint regulations of Portugal, contains 221½ grains of English standard gold?

6400 Rees = 221½ Grains of standard gold  
 480 Grains stand- } = 934½ Pence sterling.  
     ard gold }

How many pence sterling will 1000 rees give?

$$\text{Striking out the common divisor } 1000, \frac{221\frac{1}{2} \times 934\frac{1}{2}}{64 \times 48} =$$

69,35*d.* sterling for the milree.

*Example 2.*—What is the intrinsic par between London and Madrid, in *silver*, the weight of the dollar being 17 dwt. 8 gr. Troy, and its fineness 8 dwt. worse

than English standard, according to average assays lately made at his majesty's mint at the Tower of London.

85 Dollars of exchange = 64 Hard dollars  
 1 Hard Dollar = 416 Grains Troy  
 222 Grains in dollars = 214 Grains standard  
 480 Grains standard = 62 Pence sterling.

How many pence sterling does 1 dollar of exchange give?

$$\text{Striking out the common divisor } 64, \frac{416 \times 214 \times 62}{85 \times 111 \times 15} = 39\frac{1}{2} \text{d. sterling for the dollar of exchange.}$$

*Example 3.*—What is the intrinsic par between London and Amsterdam, in *silver*, when taken from the rixdollar current, which weighs 18 dwt. Troy, and is (according to assays) 16 dwt. worse than English standard, taking the agio of banco on currency at 4 per cent.

62 Pence sterling = 20 Dwt. standard silver  
 202 Dwt. standard = 222 Dwt. in rixdollars  
 18 Dwt. or 1 rixdollar = 50 Stivers currency  
 1 Stiver = 2 Grotes  
 12 Grotes = 1 Shilling Flemish  
 104 Shillings Flemish } = { 100 Shillings Flemish  
     currency }                      banco.

How many shillings Flemish banco do 240 pence sterling give?

*Brought down and reduced.*

31	6½	20	5
103	108	111	37
5	13	50	50
13	104	100	25
		110	20

$$\frac{5 \times 37 \times 50 \times 25 \times 20}{31 \times 103 \times 3 \times 13} = 37\frac{1}{2} \text{d. Flemish for the pound sterling.}$$

TABLE of the intrinsic par of exchange between London and the principal places in Lloyd's list, gold against gold, and silver against silver, calculated according to the mint regulations of each place respectively.

	In Gold.	In Silver.
Amsterdam, currency	f. d. Flem. 37 4.9	f. d. Flem. 38 1
"    "    banco	35 11.6	36 7.5
(agio 4 per cent.)		
Rotterdam, currency	flor. fliv. 11 4.5	flor. fliv. 11 8.5
Hamburgh, banco	f. d. Flem. 34 3.5	f. d. Flem. 35 1
Paris in the old coins	liv. f. den. 25 9 11	liv. f. den. 25 1 9
"    "    in the new coins	25 10 6	25 0 9½
	fr. cents. or 25 21	fr. cents. or 24 73
Genoa - - -	d. ster. 45.52	d. ster. 46
Leghorn - - -	49.09	46.67
Naples - - -	42.57	43.5
Lisbon - - -	67.4	69.4
Madrid } - - -	37.3	39.22
Cadiz }		
Venice - - -	lire 46.8	lire 47.5

TABLE

## EXCHANGE.

TABLE of the intrinsic par of exchange between London and the principal places in Lloyd's List, gold against gold, and silver against silver, calculated from assays lately made both in London and Paris.

	In Gold.	In Silver.
	f. d. Flem.	f. d. Flem.
Amsterdam, currency	37 4	38 7½
—, banco	35 10.8	37 1.7
(agio 4 per cent.)	flor. stiv.	flor. stiv.
Rotterdam, currency	11 4	11 14
	f. d. Flem.	f. d. Flem.
Hamburgh, banco	34 2.4	35 1
	liv. f. den.	liv. f. den.
Paris, in the old coins	25 9 9	25 9 9
—, in the new coins	25 11 6.2	25 3 7½
	fr. cents.	fr. cents.
	or 25 26	or 24 87
	d. ster.	d. ster.
Genoa - -	45.52	45.82
Leghorn - -	49.05	46.57
Naples - -	42	41.25
Lisbon - -	66.5	63.4
Madrid } - -	36.05	39
Cadiz } - -	36.05	39
	lire	lire
Venice - -	46.38	48.9

From the two foregoing tables it appears, that the par in gold generally varies from that in silver, and in some places very considerably.

It also appears that the assays do not differ essentially from the mint regulations; but where any difference is found to exist, it is mostly in deficiency.

The intrinsic par of exchange between any other places, besides the above, may be determined by the foregoing rules, and from the money tables in the present article, with those given in the article COIN.

It should be observed, that in the calculation of the par for Amsterdam, the ducat is reckoned at 5 florins 5 stivers currency, but this price is subject to alteration, and therefore no permanent par in gold can be established with Holland, even if the agio were fixed. It should be also remarked, that in computing the par with Hamburgh the ducat is reckoned at 6 marks Hamburgh banco, and the Cologne mark of fine silver at 27½ marks banco, which are the common, but not constant prices, and therefore no permanent par can be established with Hamburgh, any more than with Amsterdam.

Authors on exchange are very numerous, though few can be mentioned that have produced full and accurate systems: the principal are, Kruse of Hamburgh; Ricard of Amsterdam; Gerhardt of Berlin; Marien of Spain; Senebier of Geneva; Giraudeau, Kuelle, Reishammer, and Corbaux of France; and Duboit of London. Among the productions of those writers Kruse's Hamburgh Contorist has been the most universally approved; an English translation of this system of exchanges, monies, weights and measures, with considerable additions and alterations, is now nearly printed, and will be shortly published, under the title of the "Universal Cambist;" from which the present article has been chiefly extracted.

EXCHANGE also denotes a public place, in most considerable cities, wherein the merchants, negociants, agents, bankers, brokers, interpreters, and other persons concerned in commerce, meet, on certain days, and certain times thereof, to confer, and treat together of matters relating to exchanges, remittances, payments, adventures, assurances, freights, and other mercantile negotiations both by land and sea.

In Flanders, Holland, and several cities of France, these places are called *bourses*; at Paris and Lyons, *places de change*; and in the Hanse towns, *colleges of merchants*.

These assemblies are held with so much exactness, and merchants and negociants are so indispensably required to attend at them, that a person's absence alone makes him be suspected of a failure or bankruptcy.

The most considerable exchanges in Europe are that of Amsterdam, and that of London, called the Royal Exchange. For an account of the latter, see ROYAL EXCHANGE.

The former is a large building, 230 feet long and 130 broad, round which runs a peristyle or portico, 20 feet wide. The columns of the peristyle, amounting to 46, are numbered, for the convenience of finding persons.

That of Antwerp was little inferior to either of them, till a variety of circumstances concurred to effect its ruin, and to transfer its trade to Amsterdam; the era of this important event in commercial history is about the year 1585.

Even in the time of the ancient Romans there were places for the merchants to meet, in most of the considerable cities of the empire. That said by some to have been built at Rome in the year of the city 259, 493 years before our Saviour, under the consulate of Appius Claudius and Publius Servilius, was called *collegium mercatorum*; whereof it is pretended there are still some remains, called by the modern Romans *loggia*, the lodge; and now, usually the "Place of St. George."

This notion of a Roman exchange is supposed to be founded on the authority of Livy, whose words are as follow; viz. "Certamen consulibus inciderat, uter dedicaret Mercurii ædem. Senatus a se rem ad populum rejecit utri eorum dedicatio jussu populi data esset, eum præesse annonæ, mercatorium collegium instituire jussit." Liv. lib. ii. But it must be here remarked, that *collegium* never signified a building for a society in the purer ages of the Latin tongue; so that "collegium mercatorum instituire" must not be rendered to build an exchange for the merchants, but to incorporate the merchants into a company. As Mercury was the god of traffic, this ædes Mercurii seems to have been chiefly designed for the devotions of this company or corporation.

EXCHANGE, in Law, is a mutual grant of equal interests in lands or tenements, the one in consideration of the other; and in our common law it more particularly denotes the compensation which the warrantor must make the warrantee, value for value, if the land warranted be recovered from the warrantee. Bracton, lib. ii.

The word "exchange," is so individually requisite and appropriated by law to the case now stated, that it cannot be supplied by any other word, or expressed by any circumlocution. (Co. Litt. 50, 51.) The estates exchanged must be equal in quantity (Litt. § 64, 65.), not of value, for that is immaterial, but of interest; as fee-simple for fee-simple, a lease for 20 years for a lease of 20 years, and the like. And the exchange may be of things that lie either in grant or in livery. (Co. Litt. 51.) But no livery of seisin, even in exchanges of freehold, is necessary to perfect the conveyance

conveyance (Litt. § 62.); for each party stands in place of the other and occupies his right, and each of them hath already had corporal possession of his own land. But entry must be made on both sides; for, if either party die before entry, the exchange is void for want of sufficient notoriety. (Co. Litt. 50.) And so also, if two persons, by consent of patron and ordinary, exchange their preferments; and the one is presented, instituted, and inducted, and the other is presented, and instituted, but dies before induction; the former shall not keep his new benefice, because the exchange was not completed; and therefore he shall return back to his own. (Park, § 288.) For if, after an exchange of lands or other hereditaments, either party be evicted of those, which were taken by him in exchange, through defect of the other's title, he shall return back to the possession of his own, by virtue of the implied warranty contained in all exchanges. Blackst. Comm. book ii. See WARRANTY.

EXCHANGE of goods and chattels. See SALE.

EXCHANGE, *the king's*, is the place appointed by the king for exchange of plate, or bullion for the king's coin. These places have formerly been diverse: but now there is only one, *viz.* that of the Tower of London, joined with the Mint.

EXCHANGE, *bill of*. See BILL of Exchange.

What we call re-exchange, is the due, or premium of a second exchange, when a bill is protested. See RE-EXCHANGE.

EXCHANGE brokers. See Exchange BROKERS.

EXCHANGE of Prisoners. This measure, which is dictated both by humanity, and, in general, by mutual interest, is frequently adopted by two hostile nations, for the purpose of easing themselves from the great charge incurred by the retention of prisoners of war in prisons, depots, &c. Sometimes an exchange becomes a consideration while drawing up the articles of a capitulation; especially where the besiegers consider it a matter of policy to get possession of a fortress, without being too strict in the conditions of surrender.

Thus we frequently observe, that a garrison is allowed to retire, under the express stipulation, that "no part thereof shall serve again until regularly exchanged." In such case, an immediate liberation of an equal number of those confined in the enemy's prisons ought instantly to take effect, and the persons thus discharged should be forwarded to their country; but if, as sometimes occurs at the very commencement of a war, when one party has been extensively successful, the other may not have the means of equalization in regard to the liberation of prisoners, it may occur, that months, or even years, may elapse, before such restriction may be removed.

This, indeed, is not the only point on which the matter may rest: it may sometimes happen, that a prince may feel it to be his interest not to carry an exchange into effect; and this he may justify under the ordinary circumstances attendant upon capitulation. Say, that an army surrenders simply under this condition; "that it shall not serve until duly exchanged." Here we see no obligation on the part of its superiors to make any exchange: therefore, when policy dictates such forbearance, we cannot affix any imputation on the prince, power, &c., if no exchange takes place.

If, indeed, the garrison are allowed to return to their country, or to retire unmolested, on condition that "they shall be exchanged," then, we naturally expect, that no time will be lost in liberating an equal number; diverting to the several classes of those allowed to retire, and pairing them off in a correct manner.

We have heard of evasions contrived for the express pur-

pose of detaining some individual, who, by his prowess, or abilities, may have become highly obnoxious to the enemy. This, however, can only take place where there is no person of corresponding rank, against whom he can be paired off; then the exchange necessarily becomes in a degree arbitrary; though it is a matter of courtesy, to form some equivalent, in such manner as may suit the wishes of his own government.

With a view to facilitate the exchanges occasionally ordered, as well as to obviate the million of frivolous complaints which would else be made, it is customary for powers at war either to receive agents, or to appoint supervisors, whose duty is confined solely to such matters as relate to the due subsistence of the prisoners, and to conducting whatever may relate to exchanges. Through this medium a government may always avail itself of the means of releasing any particular persons, confined as prisoners of war in the enemy's country; but, to effect this, at least to be able to command it, there must be in its power some equivalent: for it would be unreasonable to expect that a general officer should be given up, when only a colonel could be offered in exchange; but a general may be liberated by any government, for the purpose of liberating any officer of inferior rank then in the power of the enemy: and so throughout.

EXCHANGERS are those who return money beyond sea, by bills of exchange, &c. called anciently also *excambiators*, and since *remitters*.

EXCHEQUER, or simply *Chequer*, originally denotes a chess-board; or a frame divided into sixty-four squares, of two colours, whereon to play at draughts, chess, &c. See CHESS, &c.

The word is formed from the French *eschiquier*, which signifies the same. Hence, trees are said to be planted chequer-wise, in *quincunx*, when disposed so as to form diverse squares representing a chequer.

EXCHEQUER is more particularly used for a chamber, or apartment, in Westminster-hall, consisting of two parts; the court of exchequer and the lower exchequer. See COURT of Exchequer, and COURT of Exchequer-chamber.

EXCHEQUER-bills are a species of paper first established by Mr. Montague, in 1696, as a more convenient kind of security than the tallies and orders for repayment then in use, and also to supply the want of circulating cash, during the re-coinage at that period. They were then taken at the exchequer for all payments of the revenue, and, when re-issued, they were allowed 7l. 12s. per cent. interest. They have since been issued yearly for anticipating the produce of particular taxes; and they have almost constantly formed the principal article of that part of the public debt called the unfunded debt. Of late years the total amount of outstanding exchequer bills (exclusive of those charged on specific branches of the revenue) has usually been about 12 millions. The bank of England, ever since the year 1706, have been the contractors for their circulation, at a certain premium. The commissioners of the treasury are empowered, by various statutes, to borrow money, within a specific sum, limited by those statutes, by issuing exchequer bills on the credit of certain duties; which bills, by 12 Anne, cap. 11. and 12 Geo. I. cap. 11. bear an interest of 2d. a day per cent. payable to the bearers. But the interest payable on them has differed according to the current rate of interest at the time when they have been issued. Those now in circulation bear interest at the rate of 3½d. a day per cent. They are often made for 100l. each, but of late years they have been chiefly for 1000l. each, and sometimes for larger sums. These bills are numbered arithmetically,

cally, and registered accordingly, so that the principal sums may be paid off in course, the time of which is notified by public advertisement. The said exchequer bills shall be current to all receivers and collectors of the customs, excise, or any revenue, and at the receipt of the exchequer; and as any of them are paid or lent into the exchequer, the officers there shall cause tallies to be levied and delivered to the payers or lenders, as if they had made such payments or loans in specie. The instalments on loans are paid into the receipt of the exchequer in exchequer bills, which are received again by the bank as cash, either for the amount of dividends due, or in repayment of advances. When these bills are sold at a considerable discount, or any other circumstance indicates that too many of them are in circulation, it is usual to fund a part of them, that is, to convert them into a permanent debt by offering the holders of them stock in lieu of their bills. This of late has been frequently done. The total amount of exchequer bills issued for the public service between the 5th of January 1808 and the 5th of January 1809, and not redeemed within that period, was 39,735,200*l.* The unfunded debt in exchequer bills, outstanding on the 5th of January 1809, was 40,093,200*l.* The amount of exchequer bills issued for the public service in Ireland, between the 5th of January 1808 and the 5th of January 1809, and not redeemed within that period, was 541,666*l.* 13*s.* 4*d.* If any exchequer bills be lost, upon affidavit before a *baron* of the exchequer, and certificate from him, and security given to pay the same if found, duplicates are to be made out; and when bills are defaced new ones shall be delivered. Forging of these bills, or of the indorsements on them, is felony.

EXCHEQUER, *messenger of the.* See MESSENGER.

EXCHEQUER, *Black Book of the,* is a book under the keeping of the two chamberlains of the exchequer; said to have been composed in 1175, by Gervaise of Tilbury, nephew of king Henry II. and divided into several chapters.

Herein is contained a description of the court of England, as it then stood, its officers, their ranks, privileges, wages, perquisites, powers, and jurisdiction; and the revenues of the crown, both in money, grain, and cattle. Here we find, that for one shilling, as much bread might be bought as would serve a hundred men a whole day; that the price for a fat bullock was only twelve shillings, and a sheep four, &c. Larrey, p. i. p. 394. See also DOMESDAY.

EXCISE, an inland duty, or imposition, charged on commodities of general consumption, and paid sometimes upon the consumption of the commodity, or frequently upon the retail sale, which is the last stage before the consumption. This mode of taxation was adopted among the Romans; for Augustus, after the civil wars, introduced an excise, which, though very moderate, was general. It seldom exceeded one *per cent.* but it comprehended whatever was sold in the markets or by public auction, from the most considerable purchases of lands and houses, to those minute objects which can only derive a value from their infinite multitude and daily consumption. Such a tax, however, as it affects the body of the people, has ever been the occasion of clamour and discontent. Augustus was obliged to declare by a public edict, that the support of the army depended in a great measure on the produce of the excise; and Tiberius diminished the excise to one-half, though the relief was of very short duration. It has been adopted, in more modern times, as the most economical mode of taxing the subject; the charges of laying, collecting, and managing the excise duties being considerably less in proportion than in other branches of the revenue. Besides, it renders the commodity cheaper to

the consumer than charging it with customs to the same amount would do, because this tax is generally paid in a much later stage of it. Nevertheless, the rigour and arbitrary proceedings of excise-laws seem hardly compatible with the temper of a free nation. For the frauds that might be committed in this branch of the revenue, unless a strict watch is kept, makes it necessary, wherever it is established, to give the officers a power of entering and searching the houses of such as deal in exciseable commodities, at any hour of the day, and, in many cases, of the night likewise. And the proceedings in case of transgressions are so summary and sudden, that a man may be convicted in two days' time in the penalty of many thousand pounds by two commissioners or justices of the peace; to the total exclusion of the trial by jury, and disregard of the common law. Obnoxious as the excise duty has always been, it was first suggested by the earl of Bedford, lord treasurer to king Charles I., but never actually introduced in that prince's reign. Its original establishment took place in the year 1643, when it was introduced, on the model of the Dutch prototype, by the long parliament after its rupture with the crown; and its progress has been gradual. It was at first laid upon those persons and commodities, where it was supposed the hardship would be least perceivable, *viz.* the makers and venders of beer, ale, cyder, and perry; and though it originated with the long parliament, the royalists at Oxford soon followed the example of their brethren at Westminster, by imposing a similar duty; both parties, however, protesting that it should be continued no longer than to the end of the war, and then be utterly abolished. But the parliament at Westminster soon after imposed it on flesh, wine, tobacco, sugar, and such a multitude of other commodities, that it might be fairly denominated general. This was done in pursuance of the plan laid down by Mr. Pymme, who had been intended for chancellor of the exchequer under the earl of Bedford, and who seems to have been the father of the excise. In his letter to sir John Hotham (30 May, 1643) he intimates, "that they had proceeded in the excise to many particulars, and intended to go on farther; but that it would be necessary to use the people to it by little and little." Having accustomed the people to it for some years, the succeeding champions of liberty boldly and openly declared (Ord. 14th August, 1649, ch. 50.) "the impost of excise to be the most easy, and indifferent levy that could be laid upon the people;" and accordingly it was continued during the whole usurpation. Upon the restoration of king Charles II., as it had been long established, and its produce was well known, some part of it was given to the crown, in 12 Car. II., by way of purchase for the feudal tenures and other oppressive parts of the hereditary revenue. (See REVENUE.) Notwithstanding its general unpopularity, it has been imposed on abundance of other commodities in the reigns of king William III. and of every succeeding prince, towards supporting the enormous expences occasioned by our wars on the continent. In the year 1732, the gross produce of the excise-duty amounted to 2,964,617*l.* About this time sir Robert Walpole, being of opinion, that taxes on consumable commodities, to which every citizen contributes in proportion to his consumption, and which, being included in the price of the commodity, are insensibly paid, constituted the most eligible mode of raising the revenue necessary for the public service, formed a project for the gradual abolition, not only of the taxes on land, houses, and windows, but also of the customs, by the substitution of productive excise duties. Fully apprized of the abuses and frauds to which the collection of the customs was subject, and which he had no hope of remedying, he thought that the scheme of convert-

## EXCISE.

ing the greater part of the customs into duties of excise, would be equally advantageous to government and to the fair trader; and that the excise laws might be so ameliorated, that, notwithstanding the odium generally attached to them as arbitrary, and oppressive, no just ground of complaint should remain. With a view to the execution of this plan, he obtained a revival of the salt-duties, which had been repealed some years before; but upon proposing, in the following year, to transfer the duties on wine and tobacco to the excise, "faction," says Dr. Smith (*Wealth of Nations*, vol. iii. p. 358.) "combined with the interest of smuggling merchants, raised so violent, though unjust a clamour against that bill, that the minister thought proper to drop it." The defeat of this scheme was celebrated by general rejoicings, as a deliverance from the greatest political danger.

The several commodities now subject to excise duties are ale, beer, cyder, perry, mum, metheglin, and mead; things sold by auction; bricks and tiles; candles; coaches and coach-makers; coffee, tea, chocolate, and cocoa-nuts; glass; hops; leather; linen cloths, silks, cottons, and calicoes; malt; paper; plate; salt; soap; spirituous liquors; starch, hair-powder, and stone-blue; sweets; tobacco and snuff; vinegar and verjuice; wine; and wire. See each of these articles.

In the year 1787 the various rates of duty which had been imposed at different times were consolidated; and other regulations were also adopted, by which the produce of the revenue was augmented, and the expence of collecting it materially reduced.

By 24 Geo. II. c. 40, all fines, penalties, and forfeitures, imposed by this or any other act relating to the duties of excise, shall be sued for, levied, recovered, or mitigated by such ways and means as any fine, penalty, or forfeiture is or may be recovered or mitigated by any law or laws of excise, or in the courts at Westminster, and shall be half to the king and half to him that shall inform or sue:—that is to say, if within the limits of the chief office in London, the offence shall be determined by the commissioners (or any three of them, 1 Geo. II. st. 2. c. 16.) or, in case of appeals, by the commissioners of appeals; in all other places they shall be heard and determined by any two or more justices of the peace, residing near the place where the offence was committed, or forfeiture incurred; and in case of neglect or refusal of such justices, for the space of fourteen days next after complaint made, and notice thereof given to the offender; then the sub-commissioners may hear and determine the same; and if the party find himself aggrieved by the judgment given by the said sub-commissioners, he may appeal to the next quarter-sessions, whose judgment therein shall be final. The said commissioners for appeals, and chief commissioners for excise, and all justices of the peace and sub-commissioners aforesaid, are required, upon any complaint or information exhibited of any such forfeiture made or offence committed, to summon the party accused, and upon his appearance or contempt to proceed to the examination of the fact, and on due proof thereof either by the voluntary confession of the party, or by the oath of one credible witness, to give judgment or sentence, and to issue warrants under their hands, for levying the same on the goods and chattels of the offender, and to cause sale to be made thereof, if not redeemed in (not less than four, nor more than eight days, 27 Geo. II. c. 20.) ; and for want of sufficient distress, to imprison the party offending till satisfaction be made. The justices, commissioners, or sub-commissioners, respectively, where they shall see cause, may mitigate, compound, or lessen, the forfeiture, penalty, or fine; so as the same be not made less than double the value of the duty of excise which ought to have been paid, besides the reasonable costs and charges of such officers, or others

as were employed therein, to be to them allowed by the said justices. (12 C. II. c. 24.) No appeal in any cause of excise shall be admitted, till the appellant hath deposited the single duty with the commissioners or sub-commissioners, and given security to the commissioners of appeal, or justices of the peace, where the cause is to be finally adjudged, for such forfeiture as was adjudged against him. (15 C. II. c. 13.) By the same statute all differences and appeals about the excise shall be heard in the proper county, and not elsewhere, and appeals within London and its limits, shall be within two months after judgment, and notice given or left at the dwelling house of the party, in all other places in four months and not otherwise.

By 43 Geo. III. c. 69, after fifth of July 1803, all duties, allowances, bounties and drawbacks of excise, and other duties under the management of the commissioners, granted by any act of parliament then in force, shall cease; except in cases relating to the recovery of arrears, or of any fine, &c. previously incurred. Provided that the act shall not extend to alter the duties upon malt, mum, cyder, and perry, granted by 43 Geo. III. c. 3. or upon malt, tobacco, and snuff, continued by 43 Geo. III. c. 4; (except as to the duties on tobacco licences, and on tobacco of Spain and Portugal); nor shall the act extend to the countervailing duties on importation from Ireland, or the drawbacks payable on exportation thither, according to the "Act of the Union;" (except those in respect of beer, ale, and wines, bricks and tiles, cyder and perry, hops, mead or metheglin, spirits, vellum and parchment, gilt and silver wire, and gold and silver thread, lace or fringe.) And in lieu thereof shall be raised and collected upon the several goods, wares, merchandize, and commodities, described in schedules annexed to the said act, and for the sales by auction, and upon licences mentioned in one of these schedules, the several sums and duties respectively set forth in the said schedules; and that there be allowed in respect of goods, &c. for which any duty of excise is imposed, the several drawbacks of excise as set forth in another schedule, and also all allowances directed to be made by any act in force on the said 1st of July 1803, except as herein altered. And by 43 Geo. III. c. 81. certain additional duties inserted in an annexed schedule are directed to be paid, and the drawbacks in another schedule shall be allowed; to commence from July 5, 1803, where no date is inserted in the act, and the amount of the additional duties may be added to the price of articles contracted for prior to the act. And the said new duties shall be raised, levied, collected, consumed, paid, recovered, adjudged, mitigated, and allowed, (except where altered by these acts or either of them) in the like manner, and by such means, ways, and methods as the former duties. And all conditions, regulations, rules, restrictions, and forfeitures; and every pain, penalty, fine, or forfeiture of any nature or kind whatsoever, for any offence against any act of parliament then in force; and the several clauses, powers, and directions therein contained, (unless altered hereby,) shall extend to and be applied in the execution of these acts, in as full and ample manner as if the same were repeated and re-enacted in the body of these acts, 43 Geo. III. c. 69. § 4. c. 81. § 3. And in all cases where duties are imposed or drawbacks allowed by these acts on any specific quantity of goods, the same shall apply after the same rate to any less quantity. 1d.

The excise duties of England are under the management of nine commissioners, who sit in the general "Excise office," having salaries of 1200*l.* a-year each, and they are obliged, by oath, to take no fee or reward, but from the king only. From these commissioners there lies an appeal to five others, called "Commissioners of Appeal." The commissioners

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commissioners of excise in Scotland are five in number, and have salaries of 600*l.* per annum each.

The number of officers employed in this branch of the revenue is very great. Beside the commissioners above-mentioned, and their subordinate officers, as registers, messengers, &c. there is an auditor of the excise, and an auditor of hides, with their clerks, &c. A comptroller of cash, and another of accounts, with their clerks; a register; secretary; solicitor; receiver-general, with his clerks; clerk of securities; store-keeper; house-keeper; door-keepers; general accountants, with their assistants; accountant for fines, and two accountants for the London brewery; clerk of the bills of exchange; examiners; clerk for supervisors diaries; five general surveyors; general surveyors of distillery; and brandy; examiners of the distillery, of the brewery, and of soap and candles; surveyors of glass, of coaches, and plate licences; inspector of spirituous liquors, licences, and coaches; inspectors general of coffee, tea, &c. and of brewery through England and Wales. Beside which, there are in England and Wales, exclusive of the bills of mortality, within which is the principal head office of excise, to which all other offices in the kingdom are subordinate and accountable, about fifty collectors, who go their respective rounds once in six weeks: the province of a collector comprehends several districts, within each of which there is a supervisor, under the inspection of the collector; and each district is parcelled out into out-rides and foot-walks, within each of which there is an inferior officer, constituted under the hands and seals of the commissioners, or sub-commissioners, in their respective divisions, as necessity requires, and called gauger, or exciseman, under the inspection of the supervisor, who every six weeks draws out a diary of every day's business, with remarks, and transmits it to the chief officer. Every person, previous to his appointment to the office of gauger, must procure a certificate of his age, which must be between 21 and 30; he must understand the four first rules of arithmetic, state what business he hath followed, and that he is not encumbered with debts, be of the communion of the church of England, and, if married, not have more than two children; he must nominate two able persons to be his sureties; and the certificate, containing these particulars, and written by himself, must be signed by the supervisor of the district where he lives, and accompanied with an affidavit, that he has used no bribes for obtaining this office. He is then ordered for instruction, under the care of an experienced officer, and to wait, under the denomination of an "expectant," till a vacancy happens. Upon admission of officers of every kind relating to the excise, the oaths of allegiance and supremacy, and an oath of faithfulness in the execution of the particular office, must be taken, and the declaration against transubstantiation must be subscribed. The officers of excise are appointed, and may be dismissed, replaced, or altered by the commissioners under their hands and seals; their salaries are allowed and established by the treasury: and by 1 William and Mary, c. 24. § 15. if it be proved by two witnesses that any officer has demanded or taken any money, or other reward whatever, except of the king, such offender shall forfeit his office. Officers of excise, taking a bribe, are liable to a forfeiture of 10*l.* 15 Car. II. cap. 11: and a person liable to excise duties offering them a bribe, &c. shall forfeit 50*l.* 11 Geo. cap. 30. Officers meddling in elections are subject to a penalty of 10*l.* and an incapacity of holding any office under the king, 5 W. cap. 20. And an officer, either of the excise or customs, dealing in exciseable liquors, shall forfeit 50*l.* and be incapable of any office in the revenue, 12 Geo. cap. 28. The concealment of exciseable goods is subject to a forfeiture of those goods, and treble

value, 11 Geo. cap. 30. Any person obstructing an officer in the execution of his duty, shall forfeit 10*l.* 6 Geo. cap. 21. Actions of assault upon any officer may be tried in any county, 9 Geo. II. c. 35. And if any person shall disturb or oppose any excise officer in the execution of the powers and authorities by this act granted, or any or either of them, except where other penalties are by the act provided, he shall forfeit 200*l.* 42 Geo. III. c. 38. And the same penalty is inflicted by 43 Geo. III. c. 81, in relation to that act. Officers of excise are empowered to search at all times of the day, enter warehouses, &c. And if officers suspect that exciseable goods are concealed in any place within the limits of the chief office of excise in London, upon oath by such officers before the commissioners, or any two or more of them; or if such place be in any other part of Great Britain, on oath before one or more justices of the county, &c. or suspected place, setting forth the ground of suspicion, the said commissioners, or the said justice or justices may, by special warrant, authorise such officers by day or night (but if in the night, in presence of a constable or other peace officer) to enter into such place and to seize all such goods; and if any person shall obstruct any such officers so authorised, or any one acting in the execution of such warrant, he shall forfeit 100*l.* 42 Geo. III. c. 93. The officers, in their permits for removing exciseable goods, shall express as well the time for which they shall be in force for removing such goods, as the time within which they shall be received into stock by the person to whom they are sent; and if not removed within the time limited (unavoidable accidents excepted), or, in default of such removing, if the permit shall not be returned to the officer who granted the same, the person procuring the permit shall forfeit treble value of the goods: and if not received into stock, within the time limited, by the person to whom they were permitted to be sent, they shall be deemed goods removed without a permit. 21 Geo. III. c. 55. No writ shall be sued out against any officer of excise, or his assistant, for any thing done in the execution of his office, until one calendar month's notice shall have been delivered to him, or left at his usual place of abode, clearly and explicitly containing the cause of action, the name and place of abode of the person who is to bring such action, and the name and place of abode of his attorney or agent: and the officer may at any time within such month tender amends, and plead such tender in bar of the action; and if, upon issue joined, the jury shall find the tender to have been sufficient, they shall give a verdict for the defendant; but if the jury find that no amends, or such as were not sufficient, were tendered, they shall give a verdict for the plaintiff, and such damages as they shall think proper with costs of suit. 23 Geo. III. c. 70. If any action shall be brought against an officer, &c. it shall be brought within three months after the cause of action shall arise, and not afterwards, and shall be laid in the proper county; and if the plaintiff shall be nonsuited, or discontinued, or if upon a verdict or demurrer judgment shall be given against him, the defendant shall recover treble costs.

The additional duties, which the progress of the public expenditure has rendered it necessary to impose, have greatly increased the produce of the excise, and rendered it the most important branch of the public revenue. The duties which it comprehends are divided into the permanent consolidated duties, the temporary war taxes, and the annual duties; the latter consist of the old annual malt duty, and of an additional malt duty, which, with some duties on tobacco and snuff, and some custom duties, have, since the project for selling the land-tax, been granted annually in lieu thereof.

EXCISE.

An Account of the Gross Actual Receipt in Money, Charges of Management, and Taxes repaid to Officers, Export Temporary War Taxes, and Malts and Tobacco, Annual in England, for the Year ended Exchequer, on each Article;—together with the Balance in the Hands of

Articles.	Gross Actual Receipt in Money.			Charges of Management.			Rewards to Officers and Charges on Seized Spirits, 45th and 47th Geo. III.			Taxes.			Exports.			Allowances.			Bounties.		
	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.
Auctions - - -	281,795	10	11	1,621	8	10	-	-	-	108	3	9	-	-	-	-	-	-	-	-	-
Beer - - -	2,958,224	3	11	202,052	16	2½	-	-	-	11,140	2	6½	43,355	12	1	-	-	-	-	-	-
Bricks and Tiles - - -	291,243	11	0	2,649	16	9	-	-	-	119	6	3	1,917	9	11½	-	-	-	-	-	-
Candles - - -	302,688	5	10	43,248	7	6½	-	-	-	2,631	1	6	5,503	17	0	-	-	-	-	-	-
Cocoa Nuts and Coffee - - -	199,888	0	1	7,134	15	3	-	-	-	51	17	6	78	15	0	-	-	-	-	-	-
Cyder and Perry - - -	54,272	2	8	962	17	9	-	-	-	45	3	6	5,248	4	5½	-	-	-	-	-	-
Glaſs - - -	429,307	19	5½	10,901	0	7	-	-	-	474	19	4	81,903	14	11½	-	-	-	-	-	-
Hides and Skins - - -	311,005	8	8	23,247	8	1	-	-	-	1,579	15	0	7,416	7	5½	-	-	-	-	-	-
Hops - - -	172,103	5	0½	5,206	12	11	-	-	-	72	1	9	22,468	19	8½	-	-	-	-	-	-
Licences - - -	313,471	10	2½	3,898	12	2½	-	-	-	291	13	6	-	-	-	-	-	-	-	-	-
Malt - - -	1,147,672	2	2½	326	11	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metheglin or Mead - - -	-	1	11	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper - - -	403,129	13	5½	7,742	16	9	-	-	-	705	12	10	19,199	15	10	4,315	10	6	-	-	-
Printed Goods - - -	712,245	1	5½	19,029	7	7½	-	-	-	640	19	6½	401,889	11	0	-	-	-	-	-	-
Salt - - -	1,449,200	11	0	23,526	11	2½	-	-	-	1,445	2	9	42,943	8	0½	22,747	13	5	8,019	2	-
Soap - - -	592,688	2	10	26,111	8	2	-	-	-	1,299	3	9½	12,761	17	9½	26,154	11	10½	-	-	-
Spirits } British - - -	1,346,962	14	8½	12,710	6	11	-	-	-	687	1	0	-	-	-	-	-	-	-	-	-
} Foreign - - -	1,849,330	5	11	55,982	0	6½	38,462	15	0½	953	1	0½	-	-	-	-	-	-	-	-	-
Starch - - -	52,626	5	6½	4,892	14	11½	-	-	-	229	17	6	2,097	5	0½	521	12	11½	-	-	-
Sweets - - -	27,420	7	5½	157	2	4	-	-	-	5	10	3	-	-	-	-	-	-	-	-	-
Tea - - -	2,003,479	7	11½	31,372	1	0	-	-	-	823	2	6	36,758	18	6½	-	-	-	-	-	-
Tobacco and Snuff - - -	194,436	3	6	-	-	-	-	-	-	-	-	-	1,412	0	0½	-	-	-	-	-	-
Verjuice - - -	63	16	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vinegar - - -	41,013	2	10	390	8	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wine - - -	1,222,946	9	4	40,221	13	3	-	-	-	960	4	7½	52,192	18	4	26,745	5	9½	-	-	-
Wire - - -	14,016	17	9	328	9	0	-	-	-	0	13	2½	1,749	3	10½	-	-	-	-	-	-
Total consolidated Duties.	16,310,432	12	8½	523,718	8	4½	38,462	15	0½	24,254	13	8½	737,296	19	5	80,384	13	10½	8,019	2	-
Temporary War Taxes.																					
Malt, per Act 43 Geo. III. ch. 81. }	2,251,761	0	11	639	16	3½	-	-	-	-	-	-	15,275	10	5½	-	-	-	-	-	-
Spirits } British - do. - - -	665,956	7	2½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
} Foreign - do. - - -	914,245	15	6	10	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sweets - do. - - -	4,471	1	7½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tea - do. - - -	2,003,370	18	2½	-	-	-	-	-	-	-	-	-	36,758	18	6½	-	-	-	-	-	-
Tobacco and Snuff, per Act 46 Geo III. ch. 39. }	291,454	5	6	-	-	-	-	-	-	-	-	-	2,111	2	6½	-	-	-	-	-	-
Brandy, &c. per Act 47 Geo. III. ch. 27. }	266,352	8	10½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total temporary war taxes £.	6,399,611	17	9½	650	6	5½	-	-	-	-	-	-	54,145	11	6½	-	-	-	-	-	-
Annual Duties.																					
Tobacco and Snuff, commenced 26th March - }	437,774	0	7½	22,703	13	1	-	-	-	770	10	3½	3,288	19	9½	-	-	-	-	-	-
Malt, additional - do. - - -	911,993	6	8½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Malt, Old, commenced 24th June - - - }	554,975	9	9½	100,957	0	7½	-	-	-	6,618	10	3½	-	-	-	-	-	-	-	-	-
Total Annual Duties - £.	1,904,742	17	1½	123,660	13	8½	-	-	-	7,389	0	6½	3,288	19	9½	-	-	-	-	-	-
Totals Collected:																					
Consolidated Duties - - -	16,310,432	12	5½	523,718	8	4½	38,462	15	0½	24,254	13	8½	737,296	19	5	80,384	13	10½	8,019	2	-
Temporary War Taxes - - -	6,399,611	17	9½	650	6	5½	-	-	-	-	-	-	54,145	11	6½	-	-	-	-	-	-
Annual Duties - - -	1,904,742	17	1½	123,660	13	8½	-	-	-	7,389	0	6½	3,288	19	9½	-	-	-	-	-	-
Grand Total - £.	24,614,787	7	4½	648,029	8	4	38,462	15	0½	31,643	14	3	794,731	10	9	80,384	13	10½	8,019	2	-

EXCISE.

Allowances, Bounties, Pensions, Net Produce, and Payments into the Exchequer, of the Excise Consolidated Duties, 5th January 1809; distinguishing the Gross Receipt, Net Produce, and Net Payments into the Receiver-General, at the Commencement and Termination of the Year.

Overcharges, Overpayments, Repayments per Treasury, Warrant, &c.	Annual Payments to Officers of the late Wine Licence Office, and of the late Salt Duties.	Pensions	Net Produce of each Article.	Net Payments into the Exchequer.	Exchequer Payments less than Net Produce.	Resting on the 5th January 1808.	Exchequer Payments more than Net Produce.	Resting on the 5th January 1809.	Imprests.
£. s. d.	£. s. d.	£.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
2,975 5 6	- - -	14,000	277,087 12 10	277,088 0 0	- - -	0 15 2	0 7 2	0 8 0	- - -
1,535 15 11	- - -	-	2,686,139 17 2	2,671,140 0 0	14,999 17 2	0 4 6	- - -	15,000 1 8	- - -
61 14 1	- - -	-	286,495 3 11	286,495 0 0	0 3 11	0 5 1	- - -	0 9 0	- - -
- - -	- - -	-	251,501 19 9	251,505 0 0	- - -	0 4 2	0 0 2	0 4 0	- - -
5 6 1	- - -	-	132,617 6 3	132,618 0 0	- - -	0 16 6	0 13 9	0 2 9	- - -
- - -	- - -	-	48,015 16 8	48,045 0 0	- - -	30 2 10	29 3 3	0 19 7	- - -
12,814 12 11	- - -	-	322,813 11 8	322,814 0 0	- - -	0 16 3	0 8 3	0 7 11	- - -
51 12 0	- - -	-	278,710 6 1	278,711 0 0	- - -	0 17 9	0 13 10	0 3 10	- - -
73 1 0	- - -	-	144,292 9 7	144,282 0 0	0 9 7	0 9 10	- - -	0 19 6	- - -
- - -	490 0 0	-	308,801 4 6	308,802 0 0	- - -	0 17 11	0 15 5	0 2 5	- - -
366 8 4	- - -	-	1,146,979 2 3	1,146,979 0 0	0 2 3	0 15 5	- - -	0 17 9	- - -
- - -	- - -	-	1 11 6	- - -	1 11 6	42 7 1	- - -	43 18 7	- - -
- - -	- - -	-	372,166 17 6	372,167 0 0	- - -	0 15 9	0 2 5	0 13 3	- - -
149 16 2	- - -	-	290,535 7 1	290,536 0 0	- - -	0 18 9	0 12 11	0 5 10	- - -
22,192 15 5	7,911 3 7	-	1,320,414 11 4	1,320,415 0 0	- - -	0 7 10	0 5 7	0 2 2	- - -
19 13 9	- - -	-	526,351 7 6	526,323 0 0	28 7 6	0 1 4	- - -	28 8 11	- - -
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163 1 11	- - -	-	1,753,769 7 3	1,753,512 0 0	- - -	0 1 9	12 12 8	0 8 11	42 19 11
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- - -	- - -	-	27,257 14 10	27,253 0 0	4 14 10	0 15 8	- - -	5 10 7	- - -
- - -	- - -	-	1,934,525 5 10	1,934,464 2 6	61 3 4	0 9 10	- - -	61 13 2	- - -
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- - -	- - -	-	63 16 9	- - -	63 16 9	31 12 6	- - -	95 9 3	- - -
28 3 9	- - -	-	40,594 10 2	40,595 0 0	- - -	0 14 11	0 9 9	0 5 1	- - -
354 0 2	- - -	-	1,102,572 7 9	1,102,572 0 0	0 7 9	0 3 5	- - -	0 11 2	- - -
- - -	- - -	-	11,938 11 6	11,939 0 0	- - -	0 9 6	0 8 3	0 1 3	- - -
10,810 12 3	8,391 3 7	14,000	14,835,094 3 11	14,820,009 2 6	15,162 0 3	116 7 10	76 18 9	15,244 9 2	42 19 11
817 17 6	- - -	-	2,235,027 16 7	2,235,028 0 0	- - -	0 16 7	0 3 4	0 13 3	- - -
- - -	- - -	-	665,956 7 2	665,957 0 0	- - -	0 12 11	0 12 9	0 0 1	- - -
- - -	- - -	-	914,235 5 6	914,235 0 0	0 5 6	0 12 1	- - -	0 17 7	- - -
- - -	- - -	-	4,471 1 7	4,459 0 0	13 1 7	10 18 3	- - -	23 19 1	- - -
- - -	- - -	-	1,968,611 19 7	1,968,611 2 6	0 17 1	0 2 6	- - -	0 19 8	- - -
28 17 6	- - -	-	289,314 5 5	289,314 0 0	0 5 5	0 11 1	- - -	0 16 6	- - -
278 19 0	- - -	-	266,073 9 10	266,073 0 0	0 9 10	0 2 0	- - -	0 11 11	- - -
1,125 14 0	- - -	-	6,343,690 5 10	6,343,676 2 6	14 19 7	13 15 8	0 16 2	27 19 0	- - -
- - -	- - -	-	411,010 17 6	411,011 0 0	- - -	0 9 7	0 2 6	0 7 1	- - -
239 7 1	- - -	-	911,753 19 7	911,738 0 0	15 19 7	7 1 5	- - -	23 1 1	- - -
180 8 9	- - -	-	447,219 10 0	447,278 0 0	- - -	84 5 7	58 9 11	25 15 7	- - -
419 15 10	- - -	-	1,769,984 7 2	1,770,027 0 0	15 19 7	91 16 7	58 12 5	49 3 10	- - -
0,810 12 3	8,391 3 7	14,000	14,835,094 3 11	14,820,009 2 6	15,162 0 3	116 7 10	76 18 9	15,244 9 2	42 19 11
1,125 14 0	- - -	-	6,343,690 5 10	6,343,676 2 6	14 19 7	13 15 8	0 16 2	27 19 0	- - -
419 15 12	- - -	-	1,769,984 7 2	1,770,027 0 0	15 19 7	91 16 7	58 12 5	49 3 10	- - -
2,356 2 3	8,391 3 7	14,000	22,948,768 17 0	22,933,712 5 0	15,192 19 5	222 0 2	136 7 5	15,321 12 1	42 19 11

The produce, &c. of the excise duties in Scotland for the period above stated appears from the following abstract :

	£.	s.	d.
Cash resting to be accounted for at 5th of January, 1808	38,653	1	2½
Gross receipt from 5th January, 1808, to 5th January 1809	2,086,283	19	3½
	2,124,937	0	6
Charges of management, exports, and allowances	325,768	0	10½
Disbursements out of the net produce	88,012	12	3½
Remitted to London	1,623,000	0	0
Resting to be accounted for at 5th January, 1809	83,156	7	4
	2,124,937	0	6

The total payments out of the revenue of excise, under the authority of warrants from the barons of exchequer, to the receiver-general of crown rents and casualties in Scotland, from January 5, 1808, to January 5, 1809, are as follow :

	£.	s.	d.
Salaries to the judges and officers of the three courts of session, judiciary, and exchequer, and of the admiralty and commissary courts	50,340	12	10½
Paid to those on his majesty's civil list establishment, not belonging to the three courts	22,727	10	10½
To Francis lord Napier, commissioner to the general assembly of the church of Scotland	2,000	0	0
To John Connel, procurator for the church of Scotland, to be distributed by him among itinerant preachers	1,000	0	0
To A. Mundell, without account	1,208	17	6
Total	77,277	1	3½

The total revenue of inland excise and licences, together with other fees received by revenue excise collectors in Ireland, for one year, ending the 5th of January, 1809, amounted to 1,659,838*l.* 8*s.* 9½*d.* and the total payments for management, militia, bounties, &c. out of the gross and net revenue of excise, during the same period, amounted to 531,910*l.* 9*s.* 5*d.* If we add to the above sum 1,659,838*l.* 8*s.* 9½*d.* the amount of the inland duties, viz. 429,824*l.* 11*s.* 0½*d.* the gross produce will amount to 2,089,662*l.* 19*s.* 9½*d.* and the amount of the net produce was 1,772,615*l.* 16*s.* 2½*d.*

EXCISION, in *Surgery*, is a word often used to signify the operation of cutting any tumour, or any foreign substance, off, or out of, a part of the body.

EXCITABILITY, in Dr. John Brown's hypothesis, or the *Brunonian* hypothesis; as it has been called, is nearly synonymous with the *vital principle* of medical writers in general, and signifies that quality or property of living beings, on which the phenomena of life depend.

Life itself is, in the opinion of Brown, a *forced state*, arising altogether from the action of certain agents, which he denominates *exciting powers*, upon the *excitability*; for death ensues equally, whether the exciting powers are withdrawn, or the excitability is lost. The exciting powers

consist of heat, air, food, drink, and other substances taken into the stomach, the blood, and the fluids secreted from it; as well as of certain functions of the system itself, such as muscular exertion, sensation, thought, and passion or emotion. The effect of the exciting powers acting upon the excitability, is denominated *excitement*.

This word "excitability" is to be considered as a general term, expressive of the facts ascertained by observation, but of the essential nature of which we must remain ignorant; as in the case of gravitation, &c. "We know not what excitability is," says Dr. Brown, "or in what manner it is affected by the exciting powers. But whatever it be, whether a quality or a substance, a certain portion is assigned to every being upon the commencement of its living state." He observes, however, that such expressions as a determinate portion of excitability in each living being, the exhaustion, or the accumulation of excitability, are necessarily borrowed from the qualities of material substances, in consequence of the poverty of language; and are not to be received in a strict and literal sense.

Every power, then, that acts on the living frame, according to this doctrine, is stimulant, or produces excitement by expending excitability; whence "it follows, that the whole phenomena of life, every state and degree of health and disease, are also owing to stimulus, and no other cause." By too great stimulation weakness is induced, because the excitability becomes defective; this is said to constitute a state of *indirect debility*; when the exciting powers or stimulants are withheld or diminished, weakness is likewise induced, the excitability being accumulated, or in excess; and this is denominated a state of *direct debility*. (See DEBILITY.) For "this mutual relation obtains betwixt excitability and excitement; that the more weakly the powers have acted, or the less the stimulus has been, the more abundant the excitability becomes;—the more powerful the stimulus, the excitability becomes the more exhausted." It is only then, when a mean degree of stimulus operates upon excitability at a medium, that perfect health is produced: in illustration of which a scale was drawn by Brown, (See Elements of Medicine, chap. iii. § 39. note) divided into 80 degrees of excitability opposed inversely to 80 degrees of exciting power, at each end of which is *death*; there being, in the one case, 80 degrees of excitability, and no exciting power; and in the other, 80 degrees of stimulus and no excitability; whereas *perfect health* holds the middle station, where there are 40 degrees of stimulus and of excitability respectively. Good health, however, may be considered to exist within a range of 30 or 40 degrees (15 or 20 on each side of the mean) in consequence of the constant variation of stimulus, to which man is exposed, in his food, drink, passions of the mind, &c.; but every departure from the mean of perfect health constitutes a pre-disposition to diseases of direct or indirect debility. As life is entirely regulated by excitement, and the exciting powers have a stimulating effect only, Dr. Brown affirms, that "the notion of health and disease being different states is disproved;" the operation of the powers producing or removing each state being perfectly identical: and efficacious remedies being such as oppose deficient stimulus to excessive excitement, and excessive stimulus to deficient excitement. In a word, there are but *two* forms of diseases; and both are always preceded by pre-disposition; those which arise from excessive excitement are called *sthenic* (from σθενος, strength,) and those which originate from a deficient excitement, *asthenic*. The direct tendency of this hypothesis, therefore, was to reduce the art of medicine to the simple regulation of stimuli, or of the exciting powers; it required

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us only to increase the quantity of stimulation on the one hand, or to withdraw, or rather diminish, the stimuli on the other, as the excitement happened to be too great or too little, above or below the medium of the scale of health.

As this concise statement of a medical hypothesis, which has excited great attention and much controvery, may, perhaps, be obscure to those who are unaccustomed to the study of the phenomena of animal life, we shall cite an illustration of Brown's system, drawn up by one of his pupils from a familiar operation, by which a conception of his fundamental principles may be facilitated.

"Suppose a fire to be made in a grate filled with a kind of fuel not very combustible, and which could only be kept burning by means of a machine, containing several tubes, placed before it, and constantly pouring streams of air into it. Suppose also a pipe to be fixed in the back of the chimney, through which a constant supply of fresh fuel was gradually let down into the grate, to repair the waste occasioned by the flame, kept up by the air-machine.

The grate will represent the human frame; the *fuel* in it the *matter of life* (the *excitability* of Brown, and the *sensorial power* of Darwin): the tube behind, supplying fresh fuel, will denote the power of all living systems constantly to regenerate or reproduce excitability; while the air-machine, of several tubes, denotes the various *stimuli*, or exciting powers, applied to the excitability of the body; and the flame, drawn forth in consequence of that application, represents *life*, the product of the exciting powers acting upon excitability.

As Dr. Brown has defined *life* to be "a forced state," it is fitly represented by a flame, *forcibly* drawn forth, from fuel little disposed to combustion, by the constant application of streams of air poured into it from the different tubes of a machine. If some of these tubes are supposed to convey pure, or *oxygenous* air, they will denote the highest class of exciting powers, such as opium, musk, camphor, spirits, wine, &c. (the diffusible stimuli of Dr. Brown) which bring forth for a time a greater quantity of life than usual, as the blowing in of pure air into a fire will temporarily draw forth an uncommon quantity of flame. If others of the tubes be supposed to convey common or atmospheric air, they will represent the ordinary exciting powers, or stimuli, applied to the human frame, such as heat, light, air, food, drink, &c.; while such as convey impure airs may be used to denote what have formerly been termed sedative powers, such as poisons, contagious miasmata, foul air, &c. (Sedatives are deemed by Brown stimulants of a minor force.)

The reader will now be at no loss to understand the seeming paradox of the Brunonian system, that food, drink, and all the exciting powers applied to the body, though they *support* life, yet they *consume* it; for he will see, that the application of these powers, though it brings forth *life*, yet at the same time it wastes the excitability, or *matter of life*; just as air blown into the fire brings forth more *flame*, but wastes the *fuel*, or *matter of fire*. This is conformable to the common saying, "the more a spark is blown, the brighter it burns, and the sooner it is spent." A Roman poet has given us an excellent illustration of the Brunonian system, when he says,

"Balneæ, vina, Venus, consumunt corpora nostra;  
Sed vitam faciunt balneæ, vina, Venus."

"Wine, warmth, and love our vigour drain;  
Yet wine, warmth, love our life sustain."

It will be equally easy to illustrate the two kinds of *debility*, termed *direct* and *indirect*, which, according to Brown, are the causes of all diseases; if the quantity of stimulus, or excit-

ing power, is proportioned to the quantity of excitability; that is, if no more excitement is drawn forth, than is equal to the quantity of excitability produced, the human frame will be in a state of health; just as the fire will be in a vigorous state, when no more air is blown in, than is sufficient to consume the fresh supply of fuel, constantly poured down by the tube behind. If a sufficient quantity of stimulus is not applied, or air not blown in, the excitability in the man, and the fuel in the fire, will accumulate, producing *direct debility*; for the man will become *weak*, and the fire *low*. This, carried to a certain degree, will occasion death to the fire, and extinction to the last. If again, an over proportion of stimulus be applied, or too much air blown in, the excitability will soon be wasted, and the matter of fuel almost spent: hence will arise *indirect debility*, producing the same weakness in man, and lowness in the fire as before, and equally terminating, when carried to a certain degree, in death and extinction."

The simplicity of this doctrine, contrasted with the complicated hypotheses of preceding physicians, and its happy illustration of some of the phenomena of life, (which we have noticed under the word *DEBILITY*;) speedily obtained for it a number of profelytes, in the schools of medicine, wherever it was introduced. A generalization so sweeping was, indeed, well calculated to arrest the attention, and gratify the ardour of young minds; and accordingly it was espoused with enthusiasm by the most sanguine and speculative students, and was debated and defended with a vehemence and intolerance of opposition, almost unknown in scientific discussions; and this not only at Edinburgh, where the doctrine originated, but successively in the different universities of the continent to which it was carried. To learn that there were but two forms of disease, and therefore but two indications of cure, and two sets of remedies, was particularly gratifying to those who preferred indolent hypothesis to the labour of observation. It superseded at once the practice and maxims of the Hippocratic school of experience and unremitting investigation, and reduced the art of medicine within the compass of a nut-shell.

But, true as this doctrine of excitement may be, in its application to many of the phenomena of life, it is by no means adequate to the explanation of the whole, and especially of the causes and remedies of numerous diseases: it is, moreover, inconsistent with itself in some points, and its advocates are not agreed in the interpretation of these difficulties.

There is one inconsistency so gross and obvious, in the Brunonian doctrine, that it is inconceivable how the author could have been insensible of it, or have persevered in maintaining it. In the illustration above quoted, a tube or chimney is provided, by which the fuel, or excitability, is supposed to be constantly replenished: but no such provision is mentioned by Brown. He affirms that "a certain portion of excitability is assigned to every being at the commencement of its existence, that the action of stimuli necessarily exhausts it, and that life consists in the incessant action of stimuli upon this excitability;" *i. e.* in the incessant exhaustion of it. With this statement the notion of accumulated excitability (which is said to constitute *direct debility*) is altogether incompatible: non-consumption, or rather diminished consumption, might preserve the excitability, but surely could never increase it: though somewhat might be saved, nothing could be gained, by the abstraction of stimuli; and on the re-application of the discontinued stimuli, the excitability should never be found increased or accumulated, but should be stationary at the point of interruption; or, more correctly speaking, it must always be found

found somewhat wasted, since, while life remains, it must be acted upon in some degree; while, on the other hand, every violent stimulation should, upon the same principle, rapidly waste, and hasten the irrecoverable exhaustion of the powers of life. The proposition, then, that a determinate portion of excitability is assigned to every individual, being equally inconsistent with the subsequent theorems of the system, and with matter of fact, has been either given up, or explained away, by the pseudo-Brunonians of the present day. They admit that the excitability may be partially restored or renewed by rest and food. But to make the hypothesis consistent with common sense, it requires that the process of *generating* excitability be constantly going; for even during the most profound sleep, stimuli, or, in other words, exhausting powers, are incessantly applied, the cessation of all excitement being synonymous with death.

Another inconsistency in the hypothesis, scarcely less palpable, is the statement, that *indirect* debility, which consists in exhaustion of the excitability from excessive stimulation, is to be cured, *i. e.* the excitability is to be restored, by a continuance of strong stimuli; namely, by stimuli "*little short* of those which produced the over-excitement." But, however managed, it is obvious from the hypothesis, that they must exhaust excitability, if they act at all; they must, therefore, wear out what remains of the excitability more and more, and ultimately exhaust the power. No attempts to explain away this incongruity of language can be considered successful; the alleged loss of power in the stimuli, in consequence of repetition, will only account for the less rapidity of the complete exhaustion; but exhaustion of excitability cannot be separated from the notion of stimulation.

In its application to the practice of medicine, as well as to the explanation of the action of many causes of disease, the Brunonian system is marked by a gross neglect or defiance of observation and experience. The connections and dependencies of the different functions, the local derangements which take place in the different organs, and the curative indications deduced from these, are altogether overlooked; and the variety of phenomena which result from the specific operation of various agents on the animal economy, is equally neglected. The assertion that all powers, which influence the animal body, whether productive or curative of disease, are *stimulants*, is an abuse of language not often equalled by the framers of theories. There is not only not an identity in their action;—there is scarcely any thing in common. "With regard to contagions," to use the words of an intelligent critic, "when we consider the regular and progressive series of actions, induced by these on the system; when we have observed that each contagion gives rise to a train of peculiar and characteristic phenomena, defining the disease whence the contagion originated, and terminating often in the formation and separation of a quantity of morbid matter, alone capable of propagating the same disease in others, we cannot acknowledge that identity in the operation of the exciting powers, which the Brunonians contend for. In diseases induced by contagions, in the small-pox, for example, or in lues venerea, we perceive something more than simple excitement and unvaried stimulation. Individuals of every description, whether predisposed to *sthenia* or *asthenia*, whether labouring under direct or indirect debility, may be infected; and when the disease has taken place, it runs its course under every possible modification of the excitability, &c." (See Edinburgh Med. and Surg. Journal, vol. i. p. 369.) And again, with respect to the agents of the *Materia Medica*, besides their action upon the excitability, or the degree of excitement and ex-

haustion which they produce, there are various other peculiarities in their mode of operation. "They differ in the succession of phenomena to which they give occasion; the intoxication produced by wine, opium, and some other narcotics, cannot be imitated by aromatics, by the preparations of antimony or of mercury; nor the effects of these by narcotics: they differ in their power of specifically affecting particular organs and functions, as the stomach, intestines, kidneys, skin, salivary glands, absorbent or vascular system; by emetics, purgatives, diuretics, sudorifics, mercury, digitalis, &c. They differ in their power of opposing and inducing particular organic changes and morbid affections of the system; as syphilis and biliary diseases are cured by mercurials, scurvy by vegetable acids, and uric diseases by alkalis: they differ in the durability of effect or change produced; as is obvious by comparing the momentary and fleeting effects of the diffusible stimuli, with the permanent excitement and vigour produced by tonics, as by cinchona and preparations of iron, by wholesome food and pure air." *Loc. cit.*

In short, it is obvious that the word *stimulant*, as applied to all these various actions upon the living system, no longer retains any definite meaning; but produces a jargon which may be interpreted by each individual according to his own notions. In this respect, the theory possesses an universal fitness, like Bayes' prologue, and will do for any practice that may be found most expedient. Thus mercury will be considered as the proper *stimulant* for syphilis, cinchona and arsenic for intermittents, citric acid for scurvy, and so on; for fortunately mankind have still good sense enough to accommodate their hypotheses to the results of experience: hence we do not apprehend, that many of the most implicit believers in this jargon would endanger their patients by applying the same remedies to typhus, gout, and dropsy, because they stand in the same numerical portion of the scale; or by treating phthisis, apoplexy, and the plague alike, because they are classed together in the same way!

Notwithstanding its many inconsistencies and defects, however, the Brunonian doctrine has had some beneficial influence on medical science, by inducing a particular attention to the degree of excitement, which accompanies many diseases, although it cannot be considered as the cause or essence of them. The regulation of the excitement often constitutes the most useful means of conducting these diseases through their course to a safe termination, by moderating symptoms, and keeping action within due bounds on the one hand, or supporting the languid forces of the system on the other. This is especially true with regard to contagious febrile diseases.

The doctrines of Brown are contained in the "*Elementa Medicinæ*," which were first published in Latin, and afterwards translated by himself. After his death a revised edition of this translation was published by Dr. Beddoes, in 2 vols. 8vo. 1795; and another by the author's son, Dr. William Cullen Brown, in 3 vols. 8vo. in 1804. See BROWN.

EXCITATION, (from the Latin *excito*, I excite,) denotes the act of awakening, of rousing, or of producing some power or action; thus we hear of the excitation of motion, excitation of heat, excitation of passions, &c. In natural philosophy this word is principally used in the subjects of electricity and of heat; and of these two kinds of excitation the particulars are as follows.

When a piece of amber, or of glass, or of sulphur, or in short, of any other solid, called *electric*, or *non-conductor*, is observed in common, it does not appear to have any particular power; but if it be rubbed with a dry hand, or with something else, then after a few strokes it will be found

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that it has acquired the electric virtue, so that now it will attract small bodies that are presented to it, and it will also exhibit other electrical phenomena (for which see the article *ELECTRICITY*.) In this case the electric power in the amber, or glass, or sulphur, is said to have been *excited* by the friction of the hand or other body, which therefore is called the *rubber*; for, previous to the friction, the amber, or sulphur, &c. shewed no signs of electricity, that power being, as it were, dormant in it.

Rubbing is the most general, and upon the whole, the most effectual method of exciting electrics, but there are several other modes of excitation, and indeed hardly any action, or any motion, takes place among natural bodies, which is not attended with the excitation of electricity. In general, however, the electricity is not produced in quantity sufficient to affect our senses, without the aid of proper instruments, and of course it passes unnoticed. The principal causes of the excitation of electricity are rubbing or friction, heating and cooling, melting or coagulating, evaporation and condensation, expansion and contraction, the mere juxtaposition or contact of certain bodies, solution and effervescence, and lastly some unknown action of the body in certain aquatic animals. But these methods are not indiscriminately applicable to all substances. They are confined within certain limits of application as well as of effect; and of these particulars we shall now give a regular account.

*Rubbing, or friction.*—In the science of electricity the various bodies of the earth are distinguished into electric and conductors (see *ELECTRICS* and *CONDUCTORS*;) and whenever two bodies are rubbed against each other, unless they be both very good conductors, some electricity is always produced; that is, one of the bodies acquires the positive or vitreous, and the other acquires the negative or resinous electricity; for by this means one kind of electricity cannot be produced without the other. The circumstance which, in the superficial manner of performing the experiment, makes it appear as if one kind only of electricity were produced, is that the best conductor of the two bodies concerned, being not insulated, loses its electricity as soon as it receives it; but when both bodies are insulated, each of them will become electrified by the friction, one of them acquiring the positive, and the other the negative electricity. Even two insulated perfect conductors, by the least contact or friction against each other, acquire a slight degree of electricity; but of this hereafter. The friction which is required for this excitation of electricity is not that which can scrape off or injure the surface, but a gentle pressure progressively applied with a pretty quick motion. The former hard kind of friction generates heat, but little or no electricity.

The very same body, by changing the rubber, may be caused to acquire either the positive or the negative kind of electricity; and the change is often produced by a remarkably slight alteration of circumstances, such as altering the direction of the friction, increasing or diminishing the temperature by a few degrees, and so forth. The following table exhibits the principal cases of this kind of change, *viz.* it shews what kind of rubber is required for exciting a given body positively, and what kind for exciting it negatively. Thus it appears that sealing-wax acquires the positive electricity when rubbed with a metallic body, and that it acquires the negative electricity when rubbed with furs, leather, woollen cloth, &c. Thus also it shews that baked wood is excited positively by silk, and negatively by flannel.

<i>Substance rubbed.</i>	<i>Electricity.</i>	<i>Rubber.</i>
The fur on the back of a cat.	Positive	Every substance with which it has hitherto been rubbed.
Smooth glass.	Positive	Every substance hitherto tried, excepting The fur on the back of a cat.
	Negative	
Rough glass.	Positive	Dry oiled silk, sulphur, metals. Woollen cloth, quills, wood, paper, sealing-wax, white-wax, the human hand.
	Negative	
Tourmalin.	Positive	Amber, air, <i>viz.</i> by blowing with the bellows upon it. Diamond, the human hand.
	Negative	
Hare's skin.	Positive	Metals, silk, loadstone, leather, hand, paper, baked wood. Other finer furs.
	Negative	
White silk.	Positive	Black silk, metals, black cloth. Paper, hand, hairs, weasel's skin.
	Negative	
Black silk.	Positive	Sealing-wax. Hare's, weasel's, and ferret's skin, the load stone, brass, silver, iron, the human hand.
	Negative	
Sealing-wax.	Positive	Metals. Hare's, weasel's, and ferret's skin, the hand, leather, woollen cloth, paper.
	Negative	
Baked wood.	Positive	Silk. Flannel.
	Negative	

When two electric substances, equal in every respect, are rubbed against each other, that substance which suffers the greater degree of friction acquires the *negative*, and the other acquires the *positive* electricity. Thus, if a piece of silk, A, be drawn across another piece of silk, B, in every respect equal to A, so that the surface of the whole piece, A, (*viz.* of one side of it,) be successively drawn over one part of the piece B, then A will acquire the *positive*, and B the *negative* electricity. The reason of this probably is the greater degree of heat which the rubbed part of B acquires by the friction, it having been observed by Bergman, that heat rather disposes bodies to acquire the negative electricity.

Glass, when warmed a little, as about the temperature of 110° of Fahrenheit's scale, may be excited more easily and more powerfully than at a lower temperature. A great part of this effect probably depends upon the glass being less apt to attract moisture in that elevated temperature.

Mr. Henly insulated several bodies, and in that state rubbed them, one by one, against his woollen garments, or against silk, by which means they became electrified; but he observed very great irregularities in the effects which

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were produced by substances much allied to each other, or of the same class. Thus, a guinea, a six-pence, and a piece of tin, became negative; a piece of copper, a steel button, and a silver button, positive, at least when the cloth was warm; animal substances, excepting shells, generally acquired the positive electricity; vegetables became almost always negative; but the smooth skins of bears became positive; common pebbles, marble, coal, and jet, acquired the negative electricity; gems and crystals, the positive; glazed wares and writing paper, the positive; tobacco pipe, elastic gum, a tallow candle, oiled silk, Indian ink, and blue vitriol, (*viz.* sulphate of copper,) acquired the negative electricity. Other persons have extended the list considerably farther, but it is useless to specify the particulars.

The principal requisite in the subject of electricity, is to determine the proper construction of the rubber, and the method of employing it, so as to excite the greatest possible power in a given electric.

The best rubber for a tube of smooth glass, Mr. Cavalla says, (*Treatise on Electr.*) is the rough side of black oiled silk, especially when a little amalgam has been rubbed upon it; but the best rubber for a rough glass tube, a stick of baked wood, sealing-wax, or sulphur, is soft new flannel. The rubbers of common electrical machines, wherein a glass globe, or cylinder, or circular plate is revolved, has been varied and improved progressively. The more common construction consists of nothing more than a silk cushion stuffed with hair, over which is placed a piece of leather, and upon this leather some amalgam, (*see AMALGAM for electrical purposes,*) is spread so as to adhere pretty fast to it. Some time ago it was customary, (and the practice even at present is not entirely laid aside,) to make the rubber of red basil skin stuffed with hair; but the above-mentioned silk one, which was contrived by Dr. Nouth, is much preferable. If this silk cushion, on account of adapting it to the surface of the glass, is to be fixed upon a metallic plate, then care should be taken to render the plate free from sharp points, edges or corners, and it should be concealed or covered over with the silk. In short, to construct the rubber properly, it must be made so, that the side of it which the surface of the glass enters in whirling, may be as perfect a conductor as can be made, in order to furnish an ample and ready supply of electricity, and the opposite part should be as much a non-conductor as possible, in order that none of the electricity that has been accumulated upon the glass may go back to the rubber. A piece of silk is generally fixed to the extremity of the leather which stands against the surface of the glass. The rubber of Mr. Nairne's electrical machine (*see ELECTRICAL Machine,*) consists of silk only put over the leather cushion, the piece of silk projecting a considerable way beyond the cushion, and very little amalgam is used with it: in truth no amalgam at all is put upon the rubber of this machine; but whilst the clean rubber is on, and the cylinder is turning, a piece of leather, with some amalgam spread upon it, is applied for a few seconds to the under part of the cylinder, by which means a sufficient number of particles of amalgam will fly along the surface of the glass, from the leather to the rubber.

The rubber should be supported by a spring, by which means it may easily adapt itself to the inequalities of the surface of the glass, which, with cylinders, often are very considerable. It should likewise be insulated in whatever manner it may be most convenient; for whenever insulation is not wanted, a chain or wire may be occasionally

hung upon it, by which means it will communicate with the ground or with any other body at pleasure: when there is no possibility of insulating the rubber, several of the most interesting experiments in electricity cannot be performed with the machine.

Mr. Nicholson made a great variety of experiments, respecting this mode of excitation, which are described at large in the *Philosophical Transactions* for the year 1789, and from those experiments he deduces the following inferences.

"Those experiments," he says, "shew that the office of the silk is not merely to prevent the return of electricity from the cylinder to the cushion, but that it is the chief agent in the excitation, while the cushion serves only to supply the electricity, and perhaps increase the pressure at the entering part. There likewise seems to be little reason to doubt but that the disposition of the electricity to escape from the surface of the cylinder, is not prevented by the interposition of the silk, but by a compensation after the manner of a charge, the silk being then as strongly negative as the cylinder is positive; and, lastly, that the line of light between the silk and the cushion in weak excitations, does not consist of returning electricity, but of electricity which passes to the cylinder, in consequence of its not having been sufficiently supplied, during its contact with the rubbing surface.

"When the excitation was very strong in a cylinder newly mounted, flashes of light were seen to fly across its inside, from the receiving surface to the surface in contact with the cushion, as indicated by the brush figure. These made the cylinder ring as if struck with a bundle of small twigs: they seem to have arisen from part of the electricity of the cylinder taking the form of a charge. This appearance was observed in a nine-inch, and a twelve-inch cylinder, and the property went off in a few weeks. Whence it appears to have been chiefly occasioned by the rarity of the internal air produced by handling, and probably restored by gradual leaking of the cement."

In order to determine what takes place in the inside of the cylinder, Mr. Nicholson undertook a series of experiments with a plate machine, (*see ELECTRICAL Machine,*) and from their result it appears, "that no advantage is gained by rubbing both surfaces, but that a well-managed friction on one surface will accumulate as much electricity as the present methods of excitation seem capable of collecting; but that when the excitation is weak, on account of the electric matter not passing with sufficient facility to the rubbed surface, the friction enables the opposite surface to attract or receive it, and if it be supplied, both surfaces will pass off in the positive state, and either surface will give out more electricity than is really induced upon it, because the electricity of the opposite surface forms a charge. It may be necessary to observe, that I am speaking of the facts or effects produced by friction; but how the rubbing surfaces act upon each other to produce them, whether by attraction or otherwise, I do not here enquire."

From farther experiments with the cylinder, Mr. Nicholson deduced the following conclusions: "the line, he says, of light on a cylinder departing from a simple cushion, consists of returning electricity. 2. The projecting part of the cushion compensates the electricity upon the cylinder, and by diminishing its intensity prevents its striking back in such large quantities as it would otherwise do. 3. That if there were no such compensation, very little of the excited electricity would be carried off; and, 4. That the compen-

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compensation is diminished, or the intensity increased, in an higher ratio than that of the distance of the compensating substance; because if it were not, the electricity which has been carried off from an indefinitely small distance, would never fly back from a greater distance, and from the edge of light.

“ I hope the considerable intensity I shall speak of will be an apology for describing the manner in which I produce it. I wish the theory of this very obscure process were better known; but no conjecture of mine is worth mentioning. The method is as follows:

“ Clean the cylinder and wipe the silk.

“ Grease the cylinder by turning it against a greased leather till it is uniformly obscured. I use the tallow of a candle.

“ Turn the cylinder till the silk flap has wiped off so much of the grease as to render it semi-transparent.

“ Put some amalgam on a piece of leather, and spread it well, so that it may be uniformly bright. Apply this against the turning cylinder. The friction will immediately increase, and the leather must not be removed until it ceases to become greater.

“ Remove the leather, and the action of the machine will be very strong.

“ My rubber consists of the silk flap pasted to a leather, and the cushion is pressed against the silk by a slender spiral spring in the middle of its back. The cushion is loosely retained in a groove, and rests against the spring only in such a manner, that by a sort of libration upon it as a fulcrum, it adapts itself to all the irregularities of the cylinder, and never fails to touch in its whole length. There is no adjustment to vary the pressure, because the pressure cannot be too small when the excitation is properly made. Indeed, the actual withdrawing of the cushion to the distance of one-tenth of an inch from the silk, will not materially affect a good excitation.

“ The amalgam is that of Dr. Higgins, composed of zinc and mercury. If a little mercury be added to melted zinc, it renders it easily pulverable, and more mercury may be added to the powder to make a very soft amalgam. It is apt to crystallize by repose, which seems in some measure to be prevented by triturating it with a small proportion of grease: and it is always of advantage to triturate it before using.”

The following curious fact may, perhaps, be referred to the action of friction.—If a stick of sealing-wax be broken into two pieces, the fractured parts, that is, those extremities of the pieces which were contiguous to each other, will be found electrified, one of them positively, and the other negatively.

*Heating and cooling.*—The property of exhibiting electrical phenomena by means of heating and cooling, was first observed in a hard semi-pellucid fossil, known under the name of tourmalin (called *aschentricker* by the Dutch, from its property of attracting ashes, &c. when laid near the fire. Linnæus, in his *Flora Zeylonica*, calls it *lapis electricus*.) This stone, which generally is of a deep red or purple colour, and seldom exceeds the size of a small walnut, is common in several parts of the East Indies, and especially in the island of Ceylon. Tourmalins are also found in a great many other parts of the world, and often in pretty large masses, but they are mostly opaque, and then they hardly ever shew any peculiar electric properties. (See its mineralogical characters under the article TOURMALIN.) The tourmalin's properties with respect to electricity are as follows.

1. The tourmalin, while kept in the same degree of heat,

shews no signs of electricity; but it will become electrical by increasing or diminishing its heat, and stronger in the latter than in the former circumstance. An exceedingly small variation of temperature is often sufficient to render it sensibly electrical.

2. The electricity of the tourmalin does not appear all over its surface, but only on two opposite sides, which may be called its *poles*, and they are always in one right line with the centre of the stone, and in the direction of its strata; in which direction the stone is absolutely opaque, though on the other semi-transparent.

3. Whilst the tourmalin is heating, one of its sides (distinguished by A) is electrified plus, or positively, and the other side B, minus; but when it is cooling A is minus, and B is plus.

4. If it be heated and suffered to cool without either of its sides being touched, then A will appear positive, and B negative, all the time of its heating or cooling.

5. If this stone be excited by friction, like any other electric, then each of its sides, or both at once, may be made positive.

6. If the tourmalin be heated or cooled upon some other insulated body, that body will be found electrified as well as the stone; and will be found possessed of the electricity contrary to that which is acquired by that side of the stone which was laid upon it.

7. The electricity of each side, or of both, may be reversed by heating or cooling the tourmalin in contact with various substances; thus if it be cooled, or heated, in contact with the palm of the hand, that side of it, which would have been positive if cooled in the open air, is now negative; and that which would have been negative is now positive.

8. If a tourmalin be cut into several parts, each piece will have its positive and negative poles, corresponding to the positive and negative sides of the stone from which it was cut.

9. These properties of the tourmalin are also observable in vacuo, but not so strongly as in the open air.

10. If this stone be covered all over with some electric substance, as sealing-wax, oil, &c. it will in general shew the same appearances with this coating as without it.

11. Mr. W. Canton observed a very vivid light upon the tourmalin while heating in the dark; and this is sufficient to point out which end of the stone is become positive, and which negative. Also, when the stone is strongly excited, it emits very strong flashes from the positive to the negative end, in the dark. That stone which is commonly called the “Brazilian emerald” from its colour, but which in fact is a tourmalin, also emits the abovementioned electrical light.

12. Lastly, it is to be remarked that the power of the tourmalin is sometimes injured by the action of a strong fire, at other times it is improved, and frequently it is not at all affected by it. The laws, however, of such uncertain effects, have not yet been investigated.

Most of the above-mentioned properties, which were first observed in the tourmalin, have been found to belong to some other bodies; *i. e.* there are some other substances which have the electric virtue excited in them by heating and cooling. It is to be observed that such bodies are generally, if not always, in a crystallized state; also it has been remarked that the parts which exhibit the different states of electricity differ from each other with respect to their form, although they are similarly situated: while in those crystals that are not electric, the similarly situated parts correspond also in form. If a crystal, for instance, consist of a prism terminated at each extremity by a pyramid,

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mid, and these pyramids differ as to the kind of electricity they are capable of acquiring, it will be found that they also differ in their form; one consisting of a greater number of surfaces than the other; and the part which has the greater number of faces acquires the positive electricity; the other the negative. Kidd's Outlines of Miner. vol. i.

The Abbé Haüy says, that the electricity which is produced by heat has been observed in six species of minerals, *viz.* the tourmalin, the borated magnesia or boracite, the topaz, whether from Brazil, from Saxony, or from Siberia, the mesotype of Haüy, or zeolite, the prehnite, and the oxydated zinc, or electrical calamine. See the nature of these minerals under the articles of their peculiar names. We are informed, however, that lately a gentleman, highly versed in electrical experiments, examined a vast number of specimens of the above-mentioned six minerals, and among them, (independent of the tourmalin,) he found two only that became electrical by heating and cooling; namely, the boracite and the oxydated zinc; with respect to a specimen of the latter, which had a pyramid at one end, and was truncated at the other end, he particularly observed that whilst cooling, the pyramid became negative, and the truncated side positive; but whilst heating, the pyramid became positive, though slightly so, and the truncated side did not manifest any sensible degree of electricity.

*Melting or coagulating.*—Melting or pouring a melted electric substance into another, excites electricity in various instances, and with peculiar phenomena.

If sulphur be melted in an earthen vessel, and be left to cool upon conductors; then if taken out of the vessel, when cold, it will be found strongly electrical; but not at all so, if it be left to cool upon electrics.

If sulphur be melted in glass vessels, and afterwards left to cool, they will both acquire a strong electricity, the sulphur negative, and the glass positive, whether they be left to cool upon electrics or upon conductors; however, they always acquire a stronger power in the former case than in the latter; and a stronger still, if the glass vessel is coated with metal. It is to be remarked, that the sulphur acquires no electricity till it begins to cool; its power increases in proportion as it contracts, and is the strongest when in the state of greatest contraction; but then the electricity of the glass vessel is at the same time the weakest.

If melted sulphur be poured into a vessel of baked wood, it acquires the negative electricity, and the wood the positive; but if it be poured into sulphur, or rough glass, it does not acquire any sensible degree of electricity.

Melted sulphur poured into a metal cup, and there left to cool, shews no signs of electricity whilst remaining in the cup; but if separated, they will then appear strongly electrified, the sulphur positively, and the cup negatively. If the sulphur is replaced in the cup, every sign of electricity will vanish, but, if whilst they are separate the electricity of either of them is taken off, then, on being replaced, they will both appear possessed of that kind of electricity which had not been taken off.

Melted wax, poured into glass or wood, acquires the negative electricity, and leaves the glass or wood positive. But sealing-wax poured into sulphur acquires the positive electricity, and leaves the sulphur negative. The wax-chandlers, in making their candles, often find it extremely difficult to prevent the attraction and adhesion of dust and other light bodies, in consequence of the electrified state of the wax.

Chocolate fresh from the mill, as it cools in the pans in which it is received, becomes strongly electrical. When turned out of the pans, it retains for some time this property, but

soon loses it by handling. Mr. Henly, who made these observations upon chocolate, found that by melting it again in an iron ladle, and pouring it into the tin pans as at first, would for once or twice more renew its power; but when the mass became very dry and powdery in the ladle, the electricity could no longer be revived by simple melting. However, he found that if in that state a little olive oil be added and mixed well with the chocolate in the ladle, then on pouring it into the tin pan as at first, the electric power will be found to be completely recovered.

*Evaporation and condensation.*—It was Mr. Volta who first discovered that the evaporation of water, and of most other bodies either solid or fluid that can be converted into smoke or vapour produced electricity, and not long after it was discovered that the condensation of vapour also produced electricity, but of the contrary kind. Thus when water is evaporated from an insulated vessel, that vessel remains electrified negatively, and if the vapour be received and condensed upon an insulated surface, that surface will acquire the positive electricity. These discoveries, besides their affording an easy explanation of the origin of the electricity in the clouds, fogs, &c. seem to point out a general law of nature; namely, that the capacity of water or other fluids for holding the electric fluid, is increased by the expansion of those bodies into the form of vapour; and is diminished by the contrary operation, *viz.* by the contraction of the vapour into the form of water. Therefore, in the first case, by imbibing an additional quantity of electric fluid the vapour would leave the bodies from which it departed in a negative state; and in the second case, *viz.* in the conversion of vapour into water by giving out a quantity of electric fluid, would leave the bodies that touched it in a positive state. And this is analogous to what takes place with respect to caloric and vapour.

The easiest way of shewing the production of negative electricity by evaporation is, to place a metallic cup upon a delicate electrometer, and to put a red-hot coal in it; then on pouring a few drops of water upon the coal, a sudden evaporation takes place, and the electrometer opens with negative electricity. In order to shew the positive electricity which is produced by the condensation of vapour, let a pretty long wire (*viz.* about a foot long) proceed from the top of the electrometer, and fix some pieces of paper to the farther end of the wire, then if the steam of water which issues out of the spout of a boiling kettle be directed towards the paper, the steam will be condensed upon it, and the electrometer will open with positive electricity.

The production of electricity by evaporation is not, however, always proportional to the quantity of evaporation; for instance, when water is evaporated from certain substances it produces a considerable quantity of negative electricity, but when evaporated from certain other substances, it produces little of it or none at all. Thus the flaking of quicklime produces a copious evaporation, but no electricity; and such is likewise the case with a few other substances.

All the experiments that were made, during some years subsequent to the original discovery, shewed, that if evaporation produced any electricity at all, this was of the negative kind; but at last two remarkable exceptions from this general rule were discovered, *viz.* one by a learned professor of the academy of Mantua, and the other by Mr. Cavallo; and these exceptions seem to point out a more intimate connection between the electric fluid and other bodies.

The first of the above-mentioned gentlemen found that when water is evaporated by being poured over a red-hot piece of very rusty iron, it would leave the iron and vessel upon

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which it stood electrified positively; and the same would be the case if the red-hot piece of rusty iron was thrown into the water: supposing that the latter is contained in an insulated vessel. If the iron be clean and free from rust, the electricity will be negative; if very rusty, the electricity will be positive, and if partially rusty, it will acquire little or no electricity; for in this last case the negative electricity which arises from the evaporation of water from over the clean part of the iron, is balanced by the positive electricity, which is produced by the evaporation from over the rusty part. In consequence of this, a rusty piece of iron will not serve for more than one or two experiments, for, by rendering it red-hot, part of the rust is shaken off, and at last it will act like a piece of clean iron. *Gardenii Dissert. de Electrici Ignis Natura.* § 84, 85, 86.

The other exception (which was discovered by Mr. Cavallo, and is published in the 4th edit. of his *Treat. on El.*) is shewn by means of red-hot glass. "The various degrees," Mr. C. says, "of electric powers that are produced by the evaporation of water from different substances induced me to diversify the experiments as much as I could, in order to discover, if possible, the reason why those different effects took place when the evaporation seemed to be equally quick and copious. Amongst other substances I tried glass, and found that it generally produced little or no electricity. The water was sometimes poured upon the hot glass, but in general the hot glass was dropped into the insulated water which was contained in a tin cup. However, the difference of effect was found not to be occasioned by those two different modes of proceeding. Having repeated this experiment a great many times, I at last found that the effect depended upon the different nature of the glass. If white and clean flint glass be made red-hot, and in that state be dropped into the vessel of water, a quick evaporation will ensue, and the vessel is electrified positively. If the flint glass be not very clear, there will not be any electricity generated by the evaporation. And, lastly, if the experiment be tried with glass more impure, as that of which wine bottles are made, then the negative electricity will be produced.

"In performing this experiment, it is necessary to take care that no pieces of coal adhere to the glass, which will frequently happen when a piece of glass is heated in a common fire; for in that case negative electricity will be produced by the evaporation, though the best flint glass be used."

*Expansion and contraction.*—The mere expansion of parts produces electricity in various instances; such as the dispersion of powders by projection or blowing; and the electrometer is affected by the same. It is owing to this electrified state of the powders, that several curious phenomena are exhibited by them, which could not otherwise be explained. Thus the configurations which are produced by projecting powders upon an electrophorus, or upon any electrified surface, are owing, in great measure, to this cause; thus also the dust upon the roads when properly attended to is often found to expand itself more than it apparently should, and to assume peculiar movements, in consequence of its actual electrified state, which may be easily discovered by means of a very delicate electrometer. For further particulars respecting this kind of excitation, see the article *ELECTRICAL Experiments*, and the description of Mr. Bennet's gold-leaf electrometer, under the article *ELECTROMETER*. Mr. Cavallo, in his *Treatise on Electricity*, gives the following directions for exciting powders. "Insulate," he says, "a metal plate upon an electric stand, and connect with it a cork-ball electrometer; then the powder which is required to be tried, being held in a spoon, or other thing, at about six inches above

the plate, is to be let fall gradually upon it. In this manner the electricity acquired by the powder, being communicated to the metal plate, and to the electrometer, is rendered manifest by the divergency of the threads; and its quality may be ascertained in the usual manner."

"It must be observed, that if the powder is of a conducting nature, like the amalgam of metals, or sand, &c. it must be held in some electric substance, as a glass phial, a plate of sealing-wax, or the like. Sometimes the spoon that holds the powder may be insulated; in which case, after the experiment, the spoon will be found possessed of the electricity contrary to that of the powder."

It is, however, proper to remark with respect to this kind of excitation, that the production of the electricity is in some measure due to the friction; for in the act of pouring any substance in powder from a plate, a vessel, &c. a degree of friction between the latter and the former must necessarily take place.

*Contact, or juxtaposition.*—That the mere contact of two perfect conductors would generate, or excite electricity, is a discovery of a very late date. Mr. Cavallo seems to have been the first who proved that by dropping a piece of metal upon another, a slight degree of electricity was thereby produced. (See the 4th edition of his *Treatise on Electricity*, published in 1795, third vol. *Experiments on Metallic Substances*.) Mr. Bennet also, independent of Mr. Cavallo's experiments, seems to have a claim to this discovery. The electricity thus produced was so very slight, that it could only be discovered by the nicest methods; but it was the forerunner of a most astonishing discovery. In short Mr. Volta, by repeating the contact of metallic substances, and at the same time exposing them to the action of a saline substance, produced a most powerful electrical instrument, which has opened a new field of ample and promising aspect, and has furnished the chemical philosopher with the most active engine of decomposition.

This, and the other modes of excitation that have been mentioned subsequent to it, *viz.* by means of solution, or effervescence, and by the action of the animal body, cannot be well explained, nor thoroughly understood, without a full, historical, and circumstantial account of that new and admirable branch of electricity, which is now commonly called *Galvanism*; but which in justice ought rather to be called *Voltaism*; and as it would be useless to fill this *Cyclopædia* with repetitions, we must refer our readers to the articles of the two last mentioned denominations, wherein those other modes of excitation are particularly described.

*Excitation of Heat.*—The temperature of bodies is raised either by the approach of a body hotter than themselves, or by the extrication of heat from the bodies themselves, occasioned by some particular action or disposition. The former of these methods of elevating the temperature is a mere communication of heat; for that principle continually tends to disperse itself amongst surrounding bodies, until they all acquire the same degree of temperature. The latter is called the *excitation* of heat, since an elevation of temperature takes place amongst bodies which were not hotter than the surrounding bodies a short time before. Thus, when a person stands before a common fire, heat is said to be communicated to him, but with respect to the fire itself, the heat is said to be excited, or produced by that particular decomposition of fuel which is called combustion. Thus also heat is excited by friction, by the mixture of water with sulphuric acid, and by a great many other

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other means; but it is communicated by the rays of the sun.

The means by which various degrees of sensible heat are produced and communicated, are not more than eight; *viz.* 1. Animal heat, or that power in animals which keeps them warm, and enables them to communicate heat to other bodies. 2. Compression. 3. Friction, or percussion of hard bodies. 4. Electricity. 5. Mixture. 6. Fermentation, or putrefaction. 7. The sun's rays; and, 8. The inflammation of fuel. However, by excluding the consideration of the sun's rays for reasons already assigned; by comprehending animal heat, fermentation, and inflammation under the general denomination of decomposition; and by referring the action of electricity to friction; the various modes of exciting heat, which demand our consideration in the present article, may be reduced to four; namely, compression, friction, mixture, and decomposition; and even this number may be diminished by two, since, as it will appear in the sequel, both friction and mixture may be comprehended under the head of compression; for in these two cases the excitation of heat seems to be occasioned by the compression or concentration of the integrant parts. We shall, however, for the sake of perspicuity, treat distinctly of the above-mentioned four modes.

The flattening or stretching of metallic substances, whether it be effected by means of the hammer, or screw presses, or flattening mills, or wire drawing, or any other such like means, is constantly attended with an excitation of heat, and a compression of the metallic substance. The former of these effects is perceived by the feel, or, more accurately, by the thermometer; the latter by an increase of specific gravity in the substance that has been operated upon. Not only the metals, but all other substances that are susceptible of compression, such as wood, cotton, the aerial fluids, &c. are likewise heated by the same means. On the other hand, water, hard stones, and all such bodies as cannot be condensed into a smaller space, at least not in any considerable degree, will not be heated by the above-mentioned means.

The heat, which is thus excited, differs in degree according to the nature of the substance, the violence of the pressure, and the quickness of the operation; thus a metallic substance, powerfully and quickly compressed, becomes hotter than a piece of wood similarly treated, and hotter than if it were pressed gently or slowly; for with a gentle pressure little heat is excited, and when the pressure is applied slowly, the heat is dissipated nearly as fast as it is excited.

A dexterous blacksmith, by giving a dozen or twenty smart strokes with a hammer, to the extremity of a slender iron rod upon an anvil, will render that extremity of the rod visibly red-hot, even in the day light; and this is the way by which several blacksmiths light the fire of their forges when they go to work in the morning. With respect to this operation, Dr. Black, in his Lectures, remarks, that the same extremity of the iron rod cannot be rendered red-hot a second time by hammering, unless it be first annealed, or softened in the fire. "On account," he says, "of this and other facts, I began to suspect that malleability and ductility of metals depend on a certain quantity of latent heat existing in them, which being extricated by hammering, the metals remain rigid, and require to be placed in the fire or annealed, in order to recover that latent heat."

A mixture of oxygen and hydrogen gases, if compressed, takes fire, and explodes with great violence. The mechanical condensation of vapour, and of all the aerial fluids,

is attended with a considerable elevation of temperature. The condensation of common air excites a considerable degree of heat, and, when quickly performed, it fires a variety of combustibles, such as cotton, charcoal previously warmed, tinder, &c.; and upon this principle a curious instrument has of late been contrived, by which a candle or fire may be lighted. It is nothing more than a small syringe, or little condenser, about six inches long, and not much above a quarter of an inch in diameter, (meaning the diameter of its cylindrical cavity.) It has a piston, the rod of which comes out at one end, and a stop-cock at the other end; this stop-cock is not perforated quite through, but only little more than half way, so that its cavity may either be exposed to the external air, or it may be turned towards the cylindrical cavity of the syringe. The operation is performed in the following manner: the piston is first drawn out as far as the extremity of the syringe, a little bit of *amadue*, (more commonly known by the name of German tinder,) is placed into the cavity of the stop-cock, which is afterwards turned towards the cylindrical cavity of the syringe; this done, the piston is pushed in quickly and forcibly, with one smart stroke, by which means the sudden condensation of the air excites a degree of heat sufficient to set fire to the tinder; and in fact if the stop-cock be turned outwardly immediately, after having pushed the piston in, the tinder will be found burning, and a match may be lighted by it.

From a general consideration of the effects of compression, it appears that the caloric, or that principle to which the effects of heat are attributed, is contained within the pores of other bodies, somewhat like water in the cavities of a sponge, and that by compressing the body, part of that caloric is disengaged, and becomes sensible heat. Thus when a mixture of oxygen and hydrogen gases is quickly and forcibly condensed, that operation forces the gases to abandon a quantity of caloric, which becomes sensible heat, and as it cannot be dissipated immediately, raises their temperature to a degree sufficient for their inflammation. This explanation is corroborated by the converse of the above operation, *viz.* by expansion; for when gases are expanded, they absorb an additional quantity of heat, which does not raise their temperature.

Friction is well known to excite heat, the degree of which differs in proportion to the nature of the bodies concerned, and the force which is employed. This effect of friction is so commonly experienced, and so generally used, as to require but little illustration. Rubbing the hands against each other, or against any part of the body in order to excite heat, is a general practice. Filing, turning, grinding, striking a piece of steel against a flint, the motion of the axles of wheels in their holes, &c. are common and well-known instances of friction, which excite heat. In these cases the consideration of two remarkable circumstances forcibly lead us to conclude, that the heat is excited by the compression of the parts of the bodies concerned. One of the circumstances alluded to is, that compression is the necessary consequence of friction; the other is, that such substances as are not compressible, or the compressibility of which is next to nothing, cannot be heated by means of friction.

Thus Dr. Irvine says, in his Lectures, "The most violent agitation of simple fluids, such as water or mercury, will not sensibly affect the thermometer. Heat is produced by agitation on those fluids which are compound, and whose state of existence is changed by the agitation; such as milk, and the solution of certain salts in water."

It is asserted in Nicholson's Journal for June 1808, that  
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Dr. Joseph Read found that by agitating water in a tin vessel, or in a glass one for a few minutes, the temperature of that fluid was raised about eight degrees, as it appeared from a thermometer left in it all that time. We are, however, strongly inclined to suspect that this apparent result was owing to some fallacy in the mode of conducting the experiment.

It seems, therefore, most probable, that friction produces a compression, and that the caloric is expelled from the bodies concerned, so as to become sensible heat, in consequence of that compression.

The greatest opponent to this hypothesis is count Rumford, who instituted some capital experiments, which are described at large in the *Philosophical Transactions*, and in which he succeeded to set a quantity of water actually a boiling by the friction of metal against metal. In short, the metal submitted to friction was encompassed by water, and air was carefully excluded from the surfaces in motion; yet the water became hot, and was kept boiling a considerable time. In this experiment the only obvious source of caloric, from without, as the count imagines, was through the borer employed to produce the friction; if it be true, that the water could not at the same instant be in the act of giving out and receiving heat. Mr. Wm. Henry (*Trans. of the Manchester Society*, vol. v. p. 2.) reasoning upon this experiment of count Rumford, says, "I cannot admit that the argument is demonstrative in proving the evolved caloric not to be derived from external substances; for no absurdity is implied in supposing that a body may be receiving caloric in one state, and giving it out in another." Thus these gentlemen seem to exclude the action of the compression between the metallic bodies, which is occasioned by the friction, and upon which the whole effect seems most probably to depend.

With respect to this excitation of heat by means of friction, two useful practical considerations naturally occur; *viz.* to determine which kinds of friction are capable of producing the greatest degree of heat, and in what manner the heat which arises from the friction of the parts of machinery in general, may be prevented.

The production of heat, and of actual fire, by the friction of wood against wood, seems to be the first that occurs to the human being, since the materials necessary for it are to be met with every where, and do not require any previous preparation, excepting a trifling adaptation of shape. In fact all rude nations that have any notion of fire, light their fires by this means. For this purpose, a piece of wood is laid flat nearly in an horizontal situation, and another slender piece of wood is rubbed with one extremity backward and forward over the surface of the former, until it excites heat enough to set fire to the dust that has been abraded from the wood itself by the friction. Otherwise a blunt pointed piece of wood is held perpendicularly over an horizontal piece, with its point in a little cavity on the surface of the latter, and is worked therein, like a drill, by rolling it between the hands of the operator, after the manner of a chocolate mill. Though this operation may at first sight appear to be easy and simple, and though it be readily performed by the individuals of rude nations; yet certain it is that the practice of it is not easily acquired; and in fact there are very few persons in Europe who are able to succeed in it. Professor Bartholdi says, that the best kinds of wood for this purpose are, box-wood rubbed against mulberry, or laurel against poplar, or against ivy. But the use of this mode of exciting heat amongst all civilized nations is superseded by the incomparably easier, and much more effectual method, of striking a piece of steel against the edge

of a siliceous stone. In this operation small particles of the steel are violently compressed and scraped off in an ignited state, so as to fire tinder, gun-powder, &c. The very common and general use of this method, for domestic convenience, for gun-locks, &c. renders any farther descriptions of it perfectly useless.

We have ventured to refer the excitation of heat by electricity, to friction, in consideration that electricity does not excite any heat, unless it is actually passing through bodies, which in some measure obstruct its free passage. But we must refer the reader for the farther consideration of this matter to the articles which relate to electricity.

It is a matter of great importance in mechanics to prevent, or, at least, to diminish the heat which is excited by the friction of the parts of machinery in general; and for this purpose the common practice is to interpose something of a lubricating quality between the contiguous parts of machines, *viz.* something which may hinder the too intimate contact of the parts, and whose particles are easily separated from each other. On various considerations olive oil has been found superior to any thing else in metallic machinery, and especially in watch or clock-work, when steel works in metal or in hard stone. Where wood and metals work against each other, hog's lard, or mutton-suet or such other fat or grease, is mostly used; and when wood works against wood, then the powder of black lead is found to be the most useful.

The heat which is excited by the mixture of certain bodies, comes next under consideration: the instances of this kind are very numerous, and different degrees of heat may be excited by this means, as far as actual inflammation. The following are selected. If spirit of wine be mixed with water, the mixture will instantly become hot enough to be perceived not only by means of the thermometer, but likewise by the mere application of the human hand. This heat will be gradually dissipated, so that in a few minutes' time that mixture will be found to have acquired the temperature of the surrounding bodies. On mixing a quantity of the strongest sulphuric acid with an equal quantity of water, a degree of heat is excited which exceeds that of boiling water. If a mixture of nitric and sulphuric acids be poured upon an inflammable essential oil, such as oil of cloves, oil of turpentine, &c.; the latter is thereby so heated as to burst out in flames. Water mixed with quicklime excites a considerable degree of heat. There is a kind of earth found in Derbyshire, which is called *blackwad*. If a quantity of this earth, as about half a pound or more of it, be sprinkled over with linseed oil, and be then left undisturbed, and exposed to the air, about an hour after it will be found in a state of incandescence, burning somewhat like small coal.

In all the cases of the excitation of heat by the mixture of fluids, two remarkable circumstances deserve particular consideration. One is that the heat will be excited only when the fluids have a chemical action upon each other, such as between acids and water, spirituous liquors and water, &c.; whereas, if oil be mixed with water, or water with quicksilver, no heat will be excited, because no real mixture will take place among these bodies. The other circumstance is, that whenever heat is excited by the mixture of fluids, an incorporation, or a concentration of the substances is observed; for it is always attended with a diminution of bulk. Thus a pint of alcohol and a pint of water, mixed together, will measure less than two pints. These circumstances seem to indicate, that the affinity, or the mutual attraction of the particles of the bodies concerned, occasions

sions a kind of compression, in consequence of which a certain part of the caloric is forced out, and becomes sensible heat.

The fourth cause of the excitation of heat is decomposition; and under this head we must comprehend the origin of animal heat, fermentation, putrefaction, combustion, and all other processes in which the heat is manifestly excited in consequence of the decomposition of compound bodies. But as these processes will be found treated at large under the articles of their peculiar denominations; we shall here only add a few remarks on the heat which is produced by decompositions in general. In short it seems that the caloric, like several other principles, enters more or less into the formation of compound bodies, and that in the decomposition of these bodies, where certain principles are set at liberty, and other new combinations ensue, the caloric also undergoes its changes; *viz.* it is expelled from certain bodies, and is either set entirely at liberty so as to become sensible heat, or is partially reabsorbed, in which latter case but little heat is manifested. This liberation of caloric is sometimes effected slowly, as in the process of animal life, in fermentations, &c. or it proceeds so quickly and abundantly, as to occasion actual inflammation. By the concurrence of various favourable circumstances it happens, not unfrequently, that decompositions and spontaneous inflammations take place among bodies, which, in general, are not capable of producing such phenomena. Thus, vegetable substances that have undergone torrefaction, being kept in sacks of cloth in contact with the ambient air, as coffee, the meal of grain, French beans, &c. have sometimes been known to take fire. The like effect is also produced by the generation of sulphurated and phosphorated hydrogen gas. The cause of subterraneous fires and volcanoes has in great measure been attributed to the decomposition of pyrites, or metallic sulphurets, buried in the interior of the earth. These masses of pyrites are decomposed by the contact and concurrence of water and air; and the decomposition is always accompanied by a great extrication of caloric, and a disengagement of a very inflammable gas, called *sulphurated hydrogen gas*. This gas is inflated at an elevated temperature, and communicates the inflammation to other combustibles that may be at hand.

With respect to the heat which is produced in combustions, several questions of economical use may be asked, such as the determination of the cheapest and most economical mode of employing fuel, the method of preventing the dissipation of heat, &c. but these particulars will be found under the articles FIRE, FUEL, and HEAT.

EXCITEMENT, in Dr. Browne's system of *Medicine*, nearly synonymous with life. See EXCITABILITY.

EXCLAMATION, or ECPHONESIS, in *Rhetoric*, a figure, wherein, by raising the voice, and using an interjection either expressly or understood, we testify an uncommon ardour, commotion, and passion of mind; and express the magnitude of the thing, or the importance of the occasion.

Such is, "O heavens! O earth!" &c. such also is that of Cicero against Cataline: "O times! O manners! this the senate knows, the consul sees—and yet he lives! Lives, said I? nay, and comes into the senate!"

In English the interjections O! or oh! alas! or good God! are generally adjoined in an exclamation. In Latin they use O! heu! eheu! ah! vah! pro superi! pro superum atque hominum fidem!" Sometimes, however, the interjection is understood, as, Woe is me! Miserum me! hocce seculum!

Cicero uses this figure to express a variety of passions. It often denotes resentment or indignation. Thus, after

his return from banishment, he exclaims, (*Pro Sext. c. 12.*) "O mournful day to the Senate and all good men; calamitous to the state, afflictive to me and my family; but glorious in the view of posterity!" At other times it is used to express disdain or contempt. Thus, speaking of Pompey's house, which was bought by Mark Antony, he says, (*Philipp. II. c. 12.*) "O consummate impudence! Dare you go within that house! Dare you enter the venerable threshold, and shew your audacious countenance to the tutelary deities which reside there?" It is no less adapted to express grief. Thus, Cicero says of Milo, (*Pro Milone, sub fin.*) "O that happy country, which shall receive this man! ungrateful this, if it banish him! miserable, if it lose him!" It also serves to express admiration, as when Cicero, in compliment to Cæsar, says, (*Pro Ligur. c. 2.*) "O admirable clemency! worthy of the greatest praise, the highest encomiums, and most lasting monuments!" It has its use also in ridicule and irony. Thus Cicero, in his oration for Balbus, deriding his accuser, exclaims, "O excellent interpreter of the law! master of antiquity! corrector and amender of our constitution!" The sacred writers sometimes use it by way of intreaty or wish, *Ps. lv. 6.*, and at other times in exultation and triumph, so St. Paul exclaims, (*1 Cor. xv. 25.*) "O death, where is thy sting! O grave, where is thy victory!" It is frequently joined, as in some of the preceding instances, with the figure "Interrogation." It generally follows the representation of the thing which occasions it; though it is sometimes used to introduce it, and thus it serves to prepare the mind by exciting its attention.

EXCLUSION, the act whereby a person or thing is excluded, *i. e.* shut out or set aside. A crown imports an exclusion from the papacy: he appointed a stranger his heir, in exclusion of his own relations.

Great efforts were made towards the close of the reign of king Charles II. to procure a bill of exclusion, for setting aside the duke of York, the king's brother, on account of his being a papist. See CROWN.

EXCLUSIONS, in *Mathematics*. The method of exclusions, is a way of coming at the solution of problems (in numerical cases) by previously ejecting, or excluding out of consideration, such numbers as are of no use in solving the question; whereby, of consequence, the process may be regularly and judiciously abbreviated.

EXCLUSIVE, is sometimes used adjectively, for the force or power of excluding; as, a patent carries with it an exclusive privilege.

Sometimes it is also used adverbially; as, he sent him all the Gazettes, from N<sup>o</sup> 195, to N<sup>o</sup> 300 exclusive; *i. e.* all between those two numbers, which themselves were excepted.

EXCLUSIVE Propositions, are those wherein the predicate so agrees with the subject, as to agree with no other. See PROPOSITION. *E. gr.* Virtue alone makes nobility: nothing else renders a man truly noble.

EXCÆCARIA, in *Botany*, from *excæco*, to deprive of sight, because, according to Rumphius, the sailors who first landed on the islands of the East Indies, where this tree grows, were greatly incommoded, and sometimes even entirely blinded, by the acrid juice which spirted forth, as they felled the wood for burning. Linn. Gen. 515. Schreb. 677. Juss. 390. Gært. t. 108. Class and order, *Diacia Triandria*. Nat. Ord. *Tricocca*, Linn. *Euphorbia*, Juss.

Gen. Ch. Male, *Cal.* Catkin cylindrical, covered with florets. *Cor.* none. *Stam.* Filaments three, thread-shaped; anthers roundish. Female, *Cal.* Catkin as in the male. *Cor.* none. *Pist.* Germen superior, roundish, somewhat triangular;

angular; styles three; stigmas simple. *Peric.* Capsule three-lobed, smooth, of three valves, each marked with a furrow, and three cells. *Seeds* solitary, smooth.

Ess. Ch. Male, Catkin naked. Perianth none. Corolla none. Female as in the male. Styles three. Capsule three-lobed. Seeds solitary.

*E. Agallocha.* Linn. Sp. Pl. 1451. (Arbor exœcans; Rumph. Amb. v. 2. 237. t. 79, 80.) Native of rocky, dry, and sandy places about the coast in Amboina and other East Indian islands, flowering in January and February, as well as occasionally at other seasons. It forms a crooked inelegant tree. The *leaves* are alternate, elliptical, bluntnish, smooth, more or less waved or bluntly crenate. *Catkins* cylindrical, lateral. *Capsules* the size of a pea. The acrid milk with which the tree abounds, causes the inhabitants of the countries where it grows to hold it in abhorrence; but Rumphius says it is chiefly dangerous to the eyes. The bark, as well as the milk, are used in medicine, being powerfully purgative. There seems to be no propriety in applying the Greek name *αγαλλοχον*, from Dioscorides, to this tree.

How far the Cammetti, Rheede Hort. Malab. v. 5. 89. t. 45, is a distinct species from the above, we have not materials to decide. Its *leaves* are more pointed and less distinctly waved. Koenig gathered it by the sea side on the coast of Coromandel, in low ground, overflowed during the rainy season, which does not agree with what Rumphius relates of the foregoing.

Loureiro describes what is probably another species, by the name of *E. cochinchinensis*, in p. 612. of his Flora Cochinch. This, he says, has beautiful shining *leaves*, red underneath, for the sake of which it is cultivated as an ornamental shrub. Its qualities are astringent and glutinous, nor did he ever hear of its being hurtful to the eyes.

**EXCOMMUNICATION**, an anathema, or ecclesiastical censure, and punishment; whereby a heretic is cut off from the society of the faithful, or an obstinate sinner from the communion of the church, and the participation of the sacraments.

This censure of excommunication was originally instituted for preserving the purity of the church; but ambitious ecclesiastics converted it by degrees into an engine for promoting their own power, and inflicted it on the most frivolous occasions.

The power of excommunication properly belongs to the bishop; but he may delegate it to any grave priest, with the chancellor.

Every excommunication should be preceded by three public admonitions, two days at least distant from each other; but this is to be understood of excommunications imposed by the ecclesiastical judge; for those imposed by the law are incurred to all intents and purposes the moment the action is committed.

These latter are called excommunications *by the canon*, or *late sententiæ*; and are so very numerous, that it would be difficult even for the best canonists to give an exact list of them; there are fifty in the Clementines; twenty in the bull *Cana Domini*, &c. Wilkins's Mag. Brit. Conc. vol. iv. p. 664. Rebuffe, on the Concordat, reckons up sixty penalties accruing upon excommunication.

Excommunication is founded on a natural right which all societies have, of excluding out of their body such as violate the laws thereof.

Excommunication is either *major* or *minor*, i. e. *greater* or *less*; the first, which is that understood when we say, simply, excommunication separates, or cuts off, the delinquent, not only from the sacraments, but from all communion and fellowship with other Christians. The second,

or lesser, only excludes from the participation of the sacraments.

The greater excommunication, called also *ab homine*, is when a prelate, or his deputy, excommunicates any man personally, and interdicts him all society with the faithful, all use of sacraments, &c.

In the ancient church, the sentences of the greater excommunication were solemnly promulged four times in the year, with candles lighted, bells tolling, the cross, and other solemnities.

The lesser excommunication is incurred *pleno jure*, by having any communication with a person excommunicated in the greater excommunication. And this too imports a privation of communion, but not an interdiction from entering the church, or having commerce with the faithful.

Anciently, the excommunicated were obliged to procure absolution from their bishop, and make satisfaction to the church in forty days' time; otherwise they were compelled to it by the secular judge, by a seizure of their effects, imprisonment of their persons, &c. (See **EXCOMMUNICATIO Capiendo**.) In France they were allowed a whole year.

By an edict of St. Louis, in the year 1228, vassals, tenants, &c. were dispensed, or freed from the oath of fidelity, homage, &c. they had taken to their lords, or superiors, when excommunicate, till they had made their submission.

In Spain, to this day, a person who is not absolved from his excommunication in a year's time is deemed a heretic. There was a time, when the people were fully convinced, that the bodies of excommunicated persons, unless they were first absolved, would not rot, but remain entire for several ages, a horrible spectacle to posterity! as is attested by Matthew Paris, and other writers. And the Greeks are still of the opinion, and affirm, they have many proofs thereof; as is shewn by Du-Cange, from the testimony of a vast number of authors.

By the laws, an excommunicated person was not to be buried, but the body flung into a pit, or covered with a heap of stones; which were called *imblocare corpus*. And by the rubric, in the Book of Common Prayer, the burial office shall not be read for any that die excommunicated. See **FUNERAL**, &c.

In the ancient church, there were diverse degrees of excommunication. In effect, excommunication did not always import an interdiction of the sacraments; but frequently, a separation, or kind of schism, between the several churches, or a suspension of spiritual communication between the bishops. But afterwards the occasions of excommunications growing more frequent, they began to use it with less circumspection and reservedness.

In the ninth century the ecclesiastics were continually making use of this spiritual weapon, to repel any violence or affronts offered them; and time and familiarity rendering offenders more and more obdurate, they proceeded, by degrees, to rigours unknown to antiquity; as the excommunicating of whole families, or provinces; prohibiting the exercise of all religion therein; and even accompanying the excommunications with horrible ceremonies, and direful imprecations.

In the tenth and eleventh centuries, the severity against the excommunicated was carried to its highest pitch: nobody might come near them, not even their own wives, children, or servants; they forfeited all their natural legal rights and privileges, and were excluded from all kinds of offices. Thus was an excommunicated king reduced to the condition of a private man. By thus stretching the power of the church to extravagance, they rendered it contempti-

ble. Gregory VII. tempered it a little; exempting the wives and children of excommunicated persons from incurring excommunication by holding conversation with their husbands and parents.

To render the excommunicated still more odious, the priest was obliged to stop, and break off divine service, if an excommunicated person entered the church; nothing of which averſion is any where diſcovered in the practice of the primitive church. At preſent we have but little of the terror or reſpect of our forefathers for excommunication; and it is even judged, and proclaimed, an abuſe, whenever impertinently employed.

The form of excommunication in the Romiſh church, as related by Fevret, is to take lighted torches, throw them on the ground with curſes and anathemas, and trample them out under-foot to the ringing of the bells.

“Auctoritate Dei Patris omnipotentis, et Filii, et Spiritus Sancti, et beatae Dei genetricis Mariae, omniumque sanctorum, excommunicamus, anathematizamus, et a limitibus sanctae matris ecclesiae sequestramus illos malefactores, N. consentaneos quoque et participes; et nisi resipuerint, et ad satisfactionem venerint, sic extinguetur lucerna eorum ante viventem in saecula saeculorum. Fiat: Amen: Amen: Amen.” Ex Emendat. Leg. Will. Conquest.

We have now none of this folly; the sentence is gravely read, and the person remains excommunicated without farther ceremony. See the form of excommunication of the English church in Concilia M. Brit. et Hib. vol. iv. p. 663, &c.

Petrus Bleſenſis aſſures us, that in England it was anciently the practice only to excommunicate ſuch as had killed an eccleſiaſtic; whereas they were put to death who had killed a layman. But the reaſon was, they held excommunication a greater puniſhment than death.

The cauſes with us are contempt of the biſhop's court, hereſy, neglect of coming to church, and of receiving the ſacrament, incontinency, adultery, ſimony, &c.

But if the judge of any ſpiritual court excommunicates a man for a cauſe of which he hath not the legal cognizance, the party may have an action againſt him at common law, and he is alſo liable to be indicted at the ſuit of the king. (2 Inſt. 623.) With us by the common law an excommunicated perſon is diſabled to do any act, that is required to be done by one that is “*probus et legalis homo*.” He cannot ſerve on juries, cannot be a witneſs in any court, and cannot bring an action, either real or perſonal, to recover lands or money due to him. (Litt. § 200.) Beſides, if, within 40 days after the ſentence has been publiſhed in the church, the offender does not ſubmit and abide by the ſentence of the ſpiritual court, the biſhop may certify ſuch contempt to the king in chancery; upon which there iſſues out a writ *De Excommunicato capiendo*; which ſee.

We have inſtances of biſhops, who have pronounced formal excommunications againſt caterpillars, and other inſects, after a formal juridical proceſs againſt them, wherein thoſe animals were allowed an advocate, and proctor to defend their cauſe. See EXORCISM.

Fevret relates divers inſtances of ſuch excommunications againſt rats, mice, and other animals, for infeſting a country. See the form of theſe excommunications in that author, Trajté de l'Albus.

In the ancient church there were two different kinds of excommunications in uſe; the one called *medicinal*, whereby perſons convicted of a crime by their own confeſſion, were removed from communion; the other, called *mortal*, was fulminated againſt rebels, who perſiſted obſtinately in their errors and impieties.

The power of excommunicating was lodged in the whole church in general; that is, the biſhops and prieſts had the adminiſtration thereof by and with the conſent of the people, which was practiſed even in St. Cyprian's time. But afterwards they ceaſed to conſult the people about the matter; the biſhop and clergy arrogated the whole power to themſelves. Recourſe, however, might ſtill be had to the ſynod of the province, to judge of the validity of an excommunication.

EXCOMMUNICATION was alſo practiſed among the Jews, who uſed to expel from their ſynagogue ſuch as had committed any grievous crime. See the Goſpel according to St. John, ix. 22. xii. 42. xvi. 2. And Joſeph. Antiq. Jud. lib. ix. cap. 22. and lib. xvi. cap. 2.

The Eſſeni, when excommunicated, durſt not ſo much as receive food at any perſon's hand, for fear of violating their oath, but contented themſelves to live on herbs; inſomuch that they frequently periſhed and died for want. See Joſeph. de Bell. lib. ii. cap. 12.

Godwyn, in his Moſes and Aaron, diſtinguiſhes three degrees, or kinds, of excommunication among the Jews.

The firſt he finds intimated in St. John ix. 22. The ſecond in St. Paul Epiſt. 1 Cor. v. 5. And the third, in the 1ſt Ep. to Corinth. xvi. 22. See NIDIVI.

The rule of the Benediſtines gives the name excommunication to the being excluded from the oratory, and the common table of the houſe in our inns of court called *diſcommuning*. This was the puniſhment of ſuch monks as came too late.

EXCOMMUNICATION, or a being ſecluded, or cut off from a participation in the myſteries of religion, was alſo in uſe under paganiſm.

Such as were thus excommunicated were forbidden to aſſiſt or attend at the ſacrifices, or to enter within the temples; and were afterwards delivered over to the dæmons and furies of hell, with certain imprecations; which was called among the Romans, *diris devovere*. See EXECRATION.

The Druids, among the ancient Britons and Gauls, likewiſe made uſe of excommunication againſt rebels; and interdicted the communion of their myſteries to ſuch as reſuſed to acquieſce in their deciſions. See DRUIDS.

That this is the true origin of the extenſive and horrid influence of the European and papal excommunication, will appear evident by the following paſſage of Cæſar, De Belló Gallico, lib. vi. cap. 13. “*Si qui aut privatus aut publicus Druidum decreto non ſtetit, ſacrificiis interdicunt. Hæc pœna apud eos eſt graviffima. Quibus ita eſt interdictum, in numero impiorum et ſceleratorum habentur, ab iis omnes decedunt, aditum eorum ſermonemque deſugiunt, ne quid ex contagione incommodi accipiant; neque iis petentibus jus redditur, neque honos ullus communicatur.*”

EXCOMMUNICATO CAPIENDO, ſo called from its effects, or *Significavit*, thus denominated from the biſhops' certificate, a writ directed to the ſheriff, for the apprehenſion of one who ſtands obſtinately excommunicated the ſpace of forty days.

Such a one not ſeeking abſolution, hath, or may have, his contempt certified into the chancery; whence this writ iſſues for taking him up and imprifoning him in the county gaol, without bail or mainprize, until he is reconciled to the church, and ſuch reconciliation is certified by the biſhop.

EXCOMMUNICATO Deliberando, is a writ directed to the under ſheriff, for the delivery of an excommunicated perſon out of priſon; upon certificate of the ordinary of his conformity to the eccleſiaſtical juriſdiction. F. N. B. 62.

EXCOMMUNICATO Recipiendo, is a writ whereby perſons excommunicated,

excommunicated, being for their obstinacy committed to prison, and unlawfully delivered from thence before they have given security to obey the authority of the church, are commanded to be fought for and laid up again.

**EXCORIATION**, in *Surgery*. A part is said to be excoriated, when it is deprived of its cuticle, by reason of inflammation; the action of irritating matter, or of stimulating substances, &c. applied to the skin.

Very superficial ulcerations are, also, frequently denominated excoriations.

In consequence of inattention to cleanliness, and not occasionally washing away the sebaceous secretion, which is naturally produced under the prepuce, the matter acquires an irritating acrid quality, brings on inflammation all round the corona glandis, followed by extensive excoriations and suppuration. This sort of case is seriously annoying to the patient, on account of the violent itching, and troublesome soreness, which always attend the complaint. The disorder has sometimes been named the *falsè gonorrhœa*, and the patient is often rendered very uneasy in his mind by an apprehension of the affection being venereal. Indeed, ignorant and careless practitioners have occasionally mistaken mere excoriations for chancres, and, quite improperly, have prescribed a course of mercury.

The proper treatment consists in washing away all the acrid secretion under the prepuce with some soap-suds; injecting under the same part, four or five times a day, the saturnine lotion; and keeping linen, wet with this application, round the extremity of the penis. The excoriations, if very bad, are to be dressed with the saturnine ointment. The prepuce, if much swelled, and in a state of phymosis, should have two or three leeches put upon it; but the principal means of cure is attention to keeping the parts clean, and tenderly washed with plenty of soap once or twice a day. As in all other cases of inflammation the bowels ought to be kept open.

Excoriation of the nipples is a most distressing complaint. It is more common in the first, than the subsequent nursings, and when independent of any disease in the child's mouth, is owing to the irritation occasioned by the suction.

In many instances, a cure may be effected by bathing the parts with a little port wine, or brandy. A more effectual remedy is said to be the tincture of opium.

**EXCORTICATION**, the act of stripping off the cortex or bark from any thing; called also decortication.

**EXCREMENT**, in *Chemistry*. See **FECES**.

**EXCREMENT**, in *Physiology*, is the residue of our food, after the nutritious particles have been extracted from it, and it has undergone certain changes by its residence in the large intestine. See **DIGESTION**.

**EXCREMENT** is also attributed, by way of analogy, to plants. Thus gums, diverse juices, balsms &c. issuing spontaneously from their respective trees, are sometimes called excrements.

**EXCRESCENCE**, in the language of *Surgery*, implies a preternatural protuberance, or any morbid growth, which projects out of the substance or surface of a part. When the disease is involved in the surrounding flesh, though it may be attended with a considerable swelling, it does not rank as an excrescence, which word essentially signifies that the tumour, or whatever the disease is, grows out of the part. Funguses, polypi, and warts of all kinds, are very often, and with strict propriety, denominated excrescences.

Excrescences, of the nature of warts, are particularly apt to grow about the anus. Some of them are generally regarded by surgical authors as venereal complaints, because

they sometimes get well under a course of mercury. This, however, is a very fallacious criterion of a disease being syphilitic; for mercury is a cure for numerous affections besides venereal ones. Some surgeons have doubted whether there is any such thing as a really venereal excrescence; and as far as our observations extend, all those warty growths which arise about the anus and perineum, and are commonly reputed to be of a syphilitic nature, may be cured upon the same principles as any other ordinary tumours, not of a specific kind.

Excrescences in general, not being original parts of the body, are known to be weak in the vital power, and to be incapable of bearing the action of such stimulating applications as would not destroy a part, which may be said to enter into the natural composition of the body. Hence it is, that sprinkling on warty excrescences a powder, consisting of favin and ærugo æris, in equal proportions, generally effects a cure. The swellings are partly diminished by absorption, and partly by sloughing. We have never seen about the anus any excrescences which could withstand this application.

But the plan which we particularly recommend to be adopted, when such excrescences are large and numerous, as they frequently are, is to remove them at once with a knife, or a pair of scissors. When they grow from a narrow neck, their destruction might be accomplished by tying them with a ligature. The latter method, indeed, is often practised by surgeons who are fearful of hæmorrhage, or whose patients have a remarkable dread of a cutting instrument, even in cases in which the object could be fulfilled much more easily, and with less pain, by means of excision; that is to say, in examples in which the base of the swellings is rather broad. Indeed, where the excrescences are connected with the skin by a wide root, the mode of removing them with a ligature becomes exceedingly troublesome and painful; for the practitioner is first under the necessity of introducing, through the centre of their base, a needle armed with a double ligature. The needle being cut off, one ligature is then to be firmly tied over one side of the root of the tumour, and the other over the opposite one. In this manner the supply of blood to the excrescence is suppressed, and the part sloughs away. Sometimes when the base of the disease is very broad, and the ligature has not been applied with due tightness, it becomes necessary to apply another one, the doing of which is attended with as much, if not more, pain than the first operation.

Upon the whole, when the excrescences are small, we prefer stimulating them with the powder of favin and ærugo æris; when they are large, we recommend extirpating them with a cutting instrument.

**EXCRETION**, from *excerno*, *I throw off*, or *separate*, is the separation of any supposed noxious matter from the blood in any of the organs of the animal body. The process itself is not essentially different from that of secretion. But the latter term is applied to those substances which, when formed, are applied to useful purposes in the animal economy. Thus the mucus of mucous membranes imparts to them a necessary moisture, and defends them from the action of the foreign matter which comes in contact with them; the serous exhalation of serous membranes preserves them constantly smooth and polished, and therefore in a fit state for their opposed surfaces to move without any obstacle, &c. The excretions are matters supposed to be noxious to the body, and to be separated on that account, as the urine, bile, perspiration, &c. The matters voided from the large intestine, consisting of the residue of our food, are often called the alvine excretions.

EXCRETORY, is applied to certain little ducts or vessels in the fabric of the glands.

Excretory ducts are the tubes through which the humours separated in the several glands are emitted or discharged out of the gland, into some convenient receptacle or emanatory.

A capillary artery, to which a capillary vein is joined, with an excretory duct, convolved or wound together, make up the body of the glands, the organs of secretion. The excretory ducts spring from the extremities of the arteries and veins, and carry off a liquor separated from the blood. Drake:

The lymphatic glands have either lymphæducts for their excretory ducts, or lacteal vessels, as in the mesentery. Idem.

EXCURSION, in *Astronomy*. See ELONGATION.

EXCURSION, *circles of*. See CIRCLES.

EXCUSABLE HOMICIDE. See HOMICIDE.

EXCUSATI, in *Church History*, a term used to denote slaves, who, flying to any church for sanctuary, were excused and pardoned by their masters; but these were obliged to take an oath to that purpose, before they could have them again; and if they broke the oath, they were punished and fined as persons guilty of perjury.

EXDORF, in *Geography*, a town of Germany, in the county of Henneberg; 7 miles S.E. of Meinungen.

EXE, a river in England, has its origin among the wild eminences of Exmoor, in the western corner of Somersetshire, and after uniting with the Barle, enters the confines of Devonshire, near Exe bridge; thence flowing near Bampton, it sinks into a rich wooded vale, and passing Tiverton, has its current increased by the streams of the Loman. Soon after, the Creedy, from Crediton, in the north-west, and the Culm, or Columb, from Cullumpton, in the north-east, intermingle their waters with the Exe, and the vale expanding, opens into a beautiful plain, encircled by towering eminences, clothed with wood. Passing Exeter, the river proceeds through a fine range of meadows to Topsham, where meeting the tide, and suddenly widening to an extent of more than a mile, it becomes navigable for vessels of several hundred tons burthen. Hence spreading into a grand estuary, it rolls onward; but its direct course being impeded by a vast sand-bank, called the Warren, it winds to the eastward, and flows into the British channel near Exmouth, its whole course being about 60 miles. See CANAL.

EXEA DE LOS CAVALLEROS, an inconsiderable town of Spain in the province of Aragon, seated between two rivulets, in the northern part of the province. Its surname commemorates the bravery of some French and Gascogne cavalry, when Alphonso I. king of Aragon, took it from the Moors. N. lat. 42° 6'. W. long. 1° 9'.

EXEAT, in *Church Discipline*, a Latin term used for a permission which a bishop grants a priest to go out of his diocese; or an abbot to a religious, to go out of his monastery.

The word is also used in several great schools for leave given a scholar or student to go out. His master has given him an exeat.

EXECRATION, EXECRATIO, among the *Ancients*, a kind of punishment, consisting of direful curses and marks of infamy. Livy relates an instance of it, which was used against Philip king of Macedon, by the Athenians. A general assembly of the people being called, they made a decree, that all the statues and images of that king, and of all his ancestors, both of the male and female sex, should be demolished, and their very names rased; that all the festivals, sacred rites, priests, and whatever else had been instituted in

honour of him, should be profaned; that the very place where there had been any monument or inscription to his honour, should be detestable, and that nothing should be set up, or dedicated in them, which could be done in clean places; and, lastly, that the public priests, as often as they prayed for the Athenian people, allies, armies, and fleets, should as many times detest and execrate Philip, his children, kingdom, land, and sea forces, and the whole race and name of the Macedonians.

Cornelius Nepos, in his life of Alcibiades, calls it *devotion*.

At the taking or demolishing of a city, it was frequent to pronounce direful curses and execrations upon any person who should endeavour to rebuild it; which some imagine was the reason that Troy could never be raised out of its ashes, though several persons attempted it, being devoted to eternal and irreparable ruin by Agamemnon. This seems to have been a very ancient custom, and derived from the Eastern nations; for we find Joshua, at the destruction of Jericho, to have fixed an imprecation upon the person who should rebuild it, which was thought to be accomplished in Hiel the Bethelite many ages after. Potter, *Archæol.* tom. ii. p. 97.

EXECREBRONCHOS, in *Surgery*, from *εξερα*, to abound, and *βρονχος*, a throat, a term which probably signified a swelling of the thyroid gland, which affection is now almost always named bronchocele.

EXECUTANT, *Fr.* in *Music*, a participle used substantively. A musician or performer who executes his part in a band, in the same sense as concertant implies a performer in a concert. See CONCERTANT, EXECUTER, and EXECUTION.

EXECUTED *Contract, Estate, Fine, and Remainder*. See the substantives.

EXECUTER, *Fr.* to execute, play, sing, or perform a composition, or piece of music, in all its parts, whether vocal or instrumental, and to let every note and passage be heard agreeable to the notation in the score.

As music is an object for the ear, it can only be judged by its effects in the execution. Many pieces of counterpoint look correct and learned on paper, which no real judge can hear without disgust; and others that look thin, simple, and common, which in the execution afford the highest pleasure, by unexpected effects. Vulgar composers, attentive to symmetry and the filling up all the parts, often appear to be great contrapuntists, while they are judged merely by the eyes; and such composers often have the address to employ so many different instruments, and such a number of parts in their music, that it is with great difficulty a sufficient band can be collected to do it justice in the execution. Rousseau.

EXECUTION, the act of executing, *i. e.* of accomplishing, finishing, or achieving any thing to be done.

We say, the execution of a testament; of a law; of a treaty; of a building, or the like.

EXECUTION, in *Common Law*, signifies the last performance of an act; as of a writ, a judgment, or the like.

EXECUTION of a judgment, denotes the putting of the law in force, or it is the obtaining the possession of any thing recovered by judgment of law.

This is performed in various ways, according to the nature of the action upon which it is founded, and of the judgment which is had or recovered. If the plaintiff recovers in an action real or mixed, whereby the seisin or possession of land is awarded to him, the writ of execution shall be an *habere facias seisinam*, or writ of seisin, of a freehold; or an *habere facias possessionem*, or writ of possession,

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of a chattel interest. (Finch. L. 470.) These are writs directed to the sheriff of the county, commanding him to give actual possession to the plaintiff, of the land so recovered; in the execution of which the sheriff may take with him the *posse comitatus*, or power of the county, and may justify breaking open doors, if the possession be not quietly delivered. But if it is peaceably yielded up, the delivery of a twig, a turf, or the ring of the door, in the name of seisin, is sufficient execution of the writ. Upon a presentation to a benefice recovered in a *quare impedit*, or assise of *darrein presentment*, the execution is by a writ *de clerico admittendo*; directed not to the sheriff, but to the bishop or archbishop, and requiring him to admit and institute the clerk of the plaintiff. In other actions, where the judgment is, that something special be done or rendered by the defendant, then, in order to compel him so to do, and to see the judgment executed, a special writ of execution issues to the sheriff, according to the nature of the case. As, upon an assise of nuisance, or *quod permittat proferre*, where one part of the judgment is *quod nocumentum amoveatur*, a writ goes to the sheriff to abate it, at the charge of the party, which likewise issues even in case of an indictment. (Comb. 10.) Upon a replevin, the writ of execution is the writ *de retorno habendo*; and if the distress be eloiigned, the defendant shall have a *capias in withernam*; but on the plaintiff's tendering the damages, and submitting to a fine, the process in *withernam* shall be stayed. (2 Leon. 174.) In detinue, after judgment, the plaintiff shall have a *distringas*, to compel the defendant to deliver the goods, by repeated distresses of his chattels, (1 Roll. Abr. 737. Ralt. Entr. 215); or also a *scire facias* against any third person in whose hands they may happen to be, to shew cause why they should not be delivered; and if the defendant still continues obstinate, then (if the judgment hath been by default or on demurrer) the sheriff shall summon an inquest to ascertain the value of the goods, and the plaintiff's damages; which (being either so assessed, or by the verdict in case of an issue, Bro. Abr. tit. *Damages*, 29.) shall be levied on the person or goods of the defendant.

Executions in actions, where money only is recovered, as a debt or damages, (and not any specific chattel,) are of five sorts: either against the body of the defendant; or against his goods and chattels; or against his goods and the profits of his lands; or against his goods and the possession of his lands; or against all three, his body, lands, and goods. The first of these species of execution is by writ of *CAPIAS ad satisfaciendum*, which see. This writ is an execution of the highest nature, inasmuch as it deprives a man of his liberty, till he makes the satisfaction awarded. When a defendant is once in custody upon this process, he is to be kept in *arcta et salva custodia*; and if he be afterwards seen at large, it is an *escape*, which see; and the plaintiff may have an action thereupon against the sheriff for his whole debt. If a *capias ad satisfaciendum* be sued out, and a *non est inventus* is returned thereon, the plaintiff may sue out a process against the bail. The second species of execution is against the goods and chattels of the defendant, and is called a writ of *FIERI facias*, which see. A third species of execution is by writ of *LEVARI facias*, which see. This affects a man's goods and the profits of his lands. This writ is now little used, the remedy by *elegit* being much more effectual. This writ of *elegit* is the fourth species of execution. Moreover, upon some prosecutions given by statute, as in the case of recognizances or debts acknowledged on statutes merchant, or statutes staple; (pursuant to the statutes 13 Ed. I. *de Mercatoribus*, and 27 Ed. III. c. 9.) upon forfeiture of these the body, land, and goods

may all be taken at once in execution, to compel the payment of the debt. This process is the fifth species of execution, and is usually called an *extent*, or *extendi facias*, which see. - It is to be observed, that all these writs of execution must be sued out within a year and a day after the judgment is entered, otherwise the court concludes *prima facie*, that the judgment is satisfied and extinct; yet, however, it will grant a writ of *scire facias*, in pursuance of statutes Westm. 2. 13 Edw. I. c. 45. for the defendant to shew cause why the judgment should not be revived, and execution had against him; to which the defendant may plead such matter as he has to allege, in order to shew why process of execution should not be issued: or the plaintiff may still bring an action of debt, founded on this dormant judgment, which was the only method of revival allowed by the common law. (Co. Litt. 290.) Blackst. Comm. B. III.

Sir Edward Coke, in his Reports, makes two sorts of executions; one *final*, another with a *quousque*, as only tending to an end.

*EXECUTION final*, is that which maketh money of the defendant's goods, or extendeth his lands, and delivers them to the plaintiff; which he accepts in satisfaction; and this is the end of the suit, and all that the king's writ commands to be done.

*EXECUTION with a quousque*, is that which only tends to an end; as in the case of a *capias ad satisfaciendum*, &c.

This is not final; but the body of the party is to be taken, to the intent and purpose to satisfy the plaintiff; and his imprisonment is not absolute, but till he doth satisfy; so that the body is but a pledge for the debt. 6 Rep. 87.

*EXECUTION, Tenant by.* See TENANT.

*EXECUTION of criminals*, must be according to judgment; and the king cannot alter a judgment from hanging to beheading, because no execution can be warranted, unless it be pursuant to the judgment. (3 Inst. 52. 211. H. P. C. 252.) But there are ancient precedents wherein men condemned to be hanged for felony, have been beheaded by force of a special warrant from the king. (Bract. 104. Staundf. 13.) And the king may pardon part of the execution in judgment for treason, *viz.* all but beheading. It has been said by sir Edward Coke, and sir Matthew Hale, that the king cannot change the punishment of the law, by altering the hanging or burning into beheading. But others have thought (Fost. 270. F. N. B. 244.), and as judge Blackstone says, more justly, that this prerogative being founded in mercy, and immemorially exercised by the crown, is part of the common law. The court may command execution to be done without any writ; (Finch, L. 478.) though sometimes execution is commanded by writ. (2 Hawk. P. C. 463.) Judgment belongs to the judge; but the execution may be done by the sheriff, or his deputy; and an execution cannot be lawfully made by any but the proper officer, whose warrant for so doing was anciently by precept of the judge under his hand and seal; as it is still practised in the court of the lord high steward, upon the execution of a peer; (2 Hal. P. C. 409.) though in the court of peers in parliament, it is done by writ from the king; and if the sheriff, or other officer alters the execution, or any other executes the offender, or if he is killed without the authority of law, it is felony. (2 Hawk. ib.) The usage now is for the judge to sign the calendar, or list of all the prisoners' names, with their separate judgments in the margin, which is left with the sheriff. As for a capital felony, it is written opposite to the prisoner's name, "let him be hanged by the neck;" formerly,

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formerly, in the days of Latin and abbreviation, "sus. per coll." for *suspendatur per collum*. And this is the only warrant which the sheriff has for so material an act, as taking away the life of another. (5 Mod. 22.) Upon this judge Blackstone observes, that it may certainly afford matter of speculation, that in civil causes there should be such a variety of writs of execution to recover a trifling debt, issued in the king's name, and under the seal of the court, without which the sheriff cannot legally stir one step; and yet that the execution of a man, the most important and terrible task of any, should depend upon a marginal note. The sheriff, upon receipt of his warrant, is to do execution within a convenient time, which in the country is also left at large. In London a more solemn and becoming exactness is used, both as to the warrant of execution, and the time of executing thereof; for the recorder, after reporting to the king in person the cases of the several prisoners, and receiving his royal pleasure, that the law must take its course, issues his warrant to the sheriffs, directing them to do execution on the day, and at the place assigned; and in the court of king's bench, if the prisoner be tried at the bar, or brought there by *habeas corpus*, a rule is made for his execution, either specifying the time and place, (State Trials, p. 332. Folt. 43.) or leaving it to the discretion of the sheriff. And, throughout the kingdom, by statute 27 Geo. II. c. 37. it is enacted, that in case of murder, the judge shall in his sentence direct execution to be performed on the next day but one after sentence passed. But otherwise, the time and place of execution are by law no part of the judgment, as was held by the twelve judges. (Mich. 10 Geo. III.) Beccaria has well observed, (On Crimes, &c. ch. 19.) that it is of great importance, that the punishment should follow the crime as early as possible; that the prospect of gratification or advantage, which tempts a man to commit the crime, should instantly awake the attendant idea of punishment. Delay of execution serves only to separate those ideas, and then the execution itself affects the minds of the spectators rather as a terrible sight, than as the necessary consequence of transgression.

In case a man condemned to die, come to life after he is hanged, as the judgment is not executed till he is dead, he ought to be hung up again. (2 Hal. P. C. 412. 2 Hawk. P. C. 463.) For the former hanging was no execution of the sentence; and if a false tenderness were to be indulged in such cases, a multitude of collusions might ensue. The body of a traitor, or felon, is forfeited to the king by the execution. Execution may be avoided by a *reprieve* or a *pardon*, which see respectively.

EXECUTION of decrees, in *Scots Law*, is effected by diligence, either against the person, or against the estate of the debtor. The first step of personal execution is by letters of horning, which pass by warrant of the court of session, on the decrees of magistrates of boroughs, sheriffs, admirals, and commissaries. If the debtor does not obey the will of the letters of horning, within the days of the charge, the charger, after denouncing him rebel, and registering the horning, may apply for letters of caption, which contain a command, not only to messengers, but to magistrates, to apprehend and imprison the debtor. All messengers and magistrates who refuse their assistance in executing the caption, are liable *sulsidiaré* for the debt; and such subsidiary action is supported by the execution of the messenger employed by the creditor, expressing that they were charged to concur, and would not. Letters of caption contain an express warrant to the messenger, in case he cannot get access, to break open all doors, and other lock-fast places. The law secures peers, married women,

and pupils, against personal execution of caption upon civil debts. Such commoners also as are elected to serve in parliament, are secured against personal execution by the privilege of parliament. No caption can be executed against a debtor within the precincts of the king's palace of Holyrood-house; but this privilege of sanctuary afforded no security to criminals, as that did which was by the canon law conferred on churches and religious houses. When the personal presence of a debtor, under caption, is necessary in any of our supreme courts, the judges are empowered to grant him a protection, for such time as may be sufficient for his coming and going, not exceeding a month. Protection from diligence is also granted by the court of session, under the late bankrupt statute, when it is applied for, with concurrence of the trustee, or a certain number of the creditors, as the case may require.

EXECUTION, *military*, is the pillage or plundering of a country by the enemy's army.

Execution also denotes every kind of punishment inflicted on an army by sentence of a court-martial. This is of various kinds; as tying up to three halberts, and receiving a number of lashes with a whip composed of nine cord-lashes, and each lash of nine knots, from the drummer; or running the gantlope through the parade at guard-mounting, drawn up in two lines for that purpose. On this occasion the provost marches through with twigs or switches, and every soldier takes as many as there are criminals to be punished; the criminal then marches through the two lines, and each soldier gives him a hard stroke, the major riding up and down, to see that the men lay on properly. When a soldier is to be punished with death, a detachment of about two hundred men from the regiment to which he belongs forms the parade, and a file of grenadiers shoots the prisoner to death. Different nations have different modes of punishment. The cat with nine tails is designed to punish foot-soldiers; but dragoons and cavalry-men are generally picketed.

EXECUTION, in *Musical Performance*, the action of conveying to the ear, by the assistance of the eye, what has been written in the score. As much music is composed of many parts so interwoven and linked together, that both the time and intonation are very difficult to seize, and of which the spirit depends more on taste than notation of such pieces, nothing is so uncommon as a perfect execution. The reading of the notes exactly is no great merit, the performer must enter into all the ideas of the composer, and feel, and make the hearer feel, the fire or pathos of the expression; but above all he must be possessed of a nice and acute ear, always attentive to the effect of the whole. In French music the leader must be particularly careful to press and relax the time according to the taste of the melody, the power of voice, and the gesticulation of the finger; the other parts must consequently be extremely attentive in following him. "The totality of the opera at Paris, where music had no other measure than the gestures of the singer, must, in my opinion, require an admirable musician indeed to keep all the performers together." N. B. This was written by Rousseau near 40 years ago, and at that time little disputed; but the editors of the late edit. of the Encyc. men of taste and judgment, will, perhaps, say with Moliere, "medicin malgre lui," this may have been so formerly, "mais, nous avons changés tout ca."

"If the French," says St. Evremond, "compose in a bolder style than formerly by their intercourse with the Italians, the Italians in their turn have gained by their commerce with the French, by learning of them a more

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agreeable touching, and perfect execution." Letter to the duke of Buckingham.

The reader (says the author of the *Lettre sur la Mus. Fran.*) will, I believe, excuse me if I wave making any remarks on this passage, I shall only observe, that the French think all the world interested about their music; but on the contrary, in three fourths of Italy, Italian musicians are totally ignorant that there exists a music in France different from their own.

A facility of reading and performing a single part is likewise called, if difficult, execution; particularly when rapid passages are played correctly, and without hesitation, at sight.

Execution of this kind depends in an especial manner on two things; the first in having a powerful hand and quick eye; and the second in having read much music, and being able to phrase it at a glance; for while we only look at single notes, we shall hesitate in pronouncing them: a great facility of execution is only acquired by uniting them into meaning, and putting the thing itself in the place of the sign. In this manner the memory of the reader of a book is no less assisted than by his eyes; and what he would read with great difficulty in a foreign language, though written or printed with the same characters as his own.

EXECUTION, in *Painting*, is a technical term signifying the style and manner in which a painter performs his work: in other words, the mechanical part of the art, as far as relates to the handling of the pencil in laying on the colours of a picture.

It is evident from this definition, that without possessing it in some degree, all knowledge of the other branches of the art is totally nugatory; to what purpose would the theory be made perfect, if no practical means of applying it were understood; but besides that degree of execution absolutely requisite to produce any thing in the shape of a picture, it well deserves to be made an object of particular study, as its various modes are productive of much utility in the progress of a picture. A great deal of the character of many objects in painting depends on the manner in which they are wrought, that is, on the peculiarity of the strokes of the pencil; such, for instance, are all skins of beasts; feathers of birds; trees; various kinds of drapery; armour, &c. in producing the effects of which, execution will alone go very far, in spite of bad form and bad colour. There is a charm in it which few perhaps but painters know, and which, unhappily, too many painters feel and value too highly, and desert for it qualities of a much more valuable kind; and are content too often to let their works pass imperfect, even with the knowledge of their imperfections, rather than disturb the beauty of clearness of touch which they may happen to possess.

It is indeed a task of no easy nature fully to obtain this quality, as it requires the utmost precision of judgment so to execute a work of art, that spirit and vigour should be maintained, accompanied with softness and truth. Without which union the display of it is a vice of art instead of an excellence, and damns instead of exalting the work.

Knowledge of the general character of the object about to be represented is the only foundation of a beautiful, decided, and just execution: possessed of that, the artist holds in his hands the master-key of the expression of its qualities, and renders its effect without difficulty. Wanting it he produces his work with heaviness, with bungling, and confusion.

It has been remarked that the countenances of men scarcely differ more than do the characters of their hand-writing, and not far, if at all, short of the variety of either of these,

is that of the manner in which painters have executed their works. Each man in this also has his peculiarity; no two are so exactly alike in the execution of their pictures that an able connoisseur would not distinguish between them, and presently attribute each to its respective author.

This discrimination of hands constitutes almost the tout-ensemble of the knowledge of the host of would-be connoisseurs; and unhappily, too many of them have obtained an influence over the opinions of men well able to teach them in better things appertaining to the arts, if common sense were allowed to rule; and this merely by having pored over the works of painters to endeavour to ascertain the distinguishing characteristics of each one's workmanship: a species of knowledge agreeable and useful to a certain degree, but of easy acquirement, and to which those who have a genuine feeling for the really good and valuable qualities pictures may possess, seldom give sufficient attention to obtain an extended information in it. The works of good artists will force themselves upon our notice, and after sufficiently admiring the general effects of beauty, of sublimity, or character they exhibit; we naturally seek to know by what means or in what manner their various parts are executed, and for the purposes of connoisseurship a satisfactory acquaintance soon takes place on that head. The works of those whose power in art is not sufficient to attract by those better qualities are surely not worthy of that close inspection which is required to become acquainted with their peculiarities of execution. But the trick of the connoisseur dealer is, by some fancied resemblance or some slight reality of resemblance, to pass off an inferior work under the sanction of a great name; while, as we have observed, if common sense were allowed to rule, the name would add no value to the picture, the tinsel would still glare under the gold, and the bauble be soon lost.

This indispensable portion of the art of painting requires early tuition in order to possess a ready power over the hand, so that it shall move freely at the command of the will to effect its desires. The same in fact is the case with regard to the acquirement of free execution in any other art, such as music, writing, &c. For though our muscles appear to act merely on our willing that their office should be performed, and without any particular direction of the power of the mind over the particular muscles which produce the motion, yet, in fact, that immediate influence is applied, although from habit and its extreme rapidity, we are insensible of the communication. This is plain when we require the use of muscles, in a direction we are not constantly in the habit of using them in. For instance, a man not accustomed to ride, or first mounting a horse, finds it necessary to exert all his mental influence to cause those muscles to act which are requisite to maintain his seat on the back of the animal, and the communication of that influence is evidently felt; but when habit has confirmed him in his seat on horse-back, though those same muscles continue to act when he is mounted, he is unconscious of constraining them to do so, the dictates of his will are then so instantaneously excited, that the connection between the exertion of its influence, and its effect is completely unobservable.

It is therefore requisite for men desirous of making considerable progress in the practical part of an art, early in life to apply themselves earnestly to its attainment. The best mode of obtaining it in painting is, by copying the works of those most skilful in their display of it, taking care at the same time to lay in a good store of knowledge of the materials requisite for the art, particularly (if historical painting be the course intended to be pursued) of the human figure, the foldings of draperies, &c. &c., and after some  
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## EXECUTION.

time spent in making copies of fine works, to paint from nature herself, keeping in view the manner in which the great painters, whose works they have imitated, saw her productions; observing how they disposed of those touches allowed to remain visible, and decided both of light and of dark; also how they characterized by their execution of the different parts; for, in a well executed work no touches are allowed to remain that are not necessary in some measure to determine the character of the object; the rest are all blended or softened together, and serve as a base to receive those finishing touches (as they are called) which are the decided features of the style of the master, (see *STYLE*, in *Painting*;) the spring of energy and vigour in the work, and without which it would appear tame and insipid.

A picture, wherein the colours and forms are blended all over, is sure to appear either solid like a stone, or have the texture of dough, of something soft and spiritless. On the contrary, where no softening takes place, and every touch remains visible, confusion inevitably reigns, with the character of tinsel, and a fluttering want of solidity.

While the student is endeavouring to acquire facility of handling his pencil, or of execution, he must take care not to be led away by its fascination, but to remember that it is only the means of presenting to the world, in an agreeable shape, other more dignified, and more valuable qualities in art, which lie deeper than the surface; and without which this is worse than an empty nothing. 'Tis the bane of many an ingenious youth who, happening to possess it early, and outshining his companions in years, satisfies himself that he has made a large advance in his art, when in fact he has obtained only a means of doing something, which more important part, his vanity leads him to forget to make the studies requisite to enable him to perform, *viz.* to acquaint himself thoroughly with the nature of bodies, and the happiest and best modes of combining them in forms and colours: and as he advances in life he is mortified to find himself surpassed by those he had regarded with contempt, but whose more steady and better directed minds have pursued attentively more valuable objects of study, and the more useful principles of their art, and now soar to a height which leaves his weaker talent far beneath.

It must, however, be remarked, that a good execution is a highly valuable quality in a picture, which being wrought with judgment, with spirit, and ease, acquires thereby an additional relish to the enjoyments its better properties dispense, and raises the artist in our estimation.

Of all those who have exhibited this talent with success, Giacomo Robusti, called Il Tintoretto, stands foremost for vigour, as has been noticed under the word *ENERGY*, in *Painting*. He has no competitor in the freedom, the boldness, and the finish of style in which his best works are executed.

Of this his picture of St. Mark descending from heaven to rescue a Christian slave condemned to torture among the Turks, originally painted for the Scudo di San Marco at Venice, but now among the spoils adorning the Louvre at Paris, is a most decided and astonishing proof. This picture is an immense work containing twenty figures or more, those in front larger than life, yet it is wrought all over with the rapidity and ease generally characteristic of small pictures, or a sketch within the compass of the hand to perform at once; and at the same time it has all the effect of rotundity of finish the most laboured works possess. In the midst of the fine pictures which surround it, it stands quite alone in its vigour of effect and splendour of colour; even a work of Rubens, who is extremely skilful in this as well as in all other branches of the art; even his, appeared compa-

ratively clumsy in its execution, though one of his finest productions, the opening of the Temple of James, or, as it is usually called, the Peace and War. Titian, from his sense and truth in the St. Peter martyr, best withstands the power of Tintoretto. The comparison of these two works may be said to be somewhat similar to that of a man of wit with a man of sense: the former shines for a moment by the brilliancy and gaiety of his genius, but when the latter is attentively heard, and his observations considered, his greater value becomes apparent.

Titian perhaps on the whole is the best model to follow for execution: he does not, like Tintoretto, leave his heads without a character in the heat of workmanship, though they are not always of the best; they are not wrought too minutely: the lights and darks are freely placed, his pencil is full and rich, and each part is made out to its full relief, and his finishing touches are laid on with the nicest discrimination of truth in direction of light and hue of colour; nothing can exceed the delicacy and skill his draperies are wrought with as to character; and though not so strong as Tintoretto's, they have sufficient force, and are far more justly disposed and characterized. After Titian in imitating him are, Velasquez and Vandyke for excellence in their execution. Of the former, a Spanish painter, there are but few works in this country, but what there are, fully justify the remark. The latter in his very finest works equals his great predecessor in this respect, many of whose pictures he carefully copied. His touch is exceedingly delicate, and his understanding of his subject enabled him to place it with the greatest justness and propriety. There is rarely seen in his works a confusion in effect or relief, and his power in his earlier productions seems to have increased with his canvas; the large picture at Wilton of the Pembroke family is wrought in a style so broad and masterly, that it appears to have been as easily managed as any of his smaller pictures; and he knew how to give with the greatest ease the just character of every object he attempted to represent. Gout and consequent weakness effected a change in his execution so great, that his hand is hardly cognizable in some of his latter works by those who have only seen his former ones. When he was in Italy, his manner was that of Titian, with somewhat of Tintoretto; from this bravura style, as it may be termed, he fell afterwards to one more tame and spiritless; softened, and rounded up, with few of those vigorous touches, and with less brilliancy of effect. Instances of both these, and also intermediate degrees, are at the earl of Egremont's at Petworth. Of the first are whole length portraits of sir Robert and lady Shirley, which he painted when he was very young at Venice; of the others, are portraits of several branches of the Pony family, who once possessed that noble mansion. Vandyck certainly surpassed his master Rubens in beauty of execution, but was more than equally surpassed by him in vigour and variety of imagination; yet the execution of Rubens was extremely powerful, but apt to become slovenly, and he is not, generally speaking, a good model to be followed on that head.

For those who are intent upon yielding the soft, the delicate, and gentle impressions produced by highly laboured works without minuteness, Correggio is the exemplar of the whole class of that style of painters. In one particular he, and our own sir Joshua, in some of their works, stand unrivalled in execution. Other painters have given a beautiful surface, which, at a proper distance, deceives the eye, and presents the full appearance of flesh: these two have, we may almost say, made flesh itself; the closest inspection merely confirms the delusion, and the observer fancies he could indent his finger in the surface, and expect it to spring again like nature;

such

Such is the fullness of the texture of the colour wrought with the many varying hues of nature. Guido Rheni follows in this class of the pleasing style. His pictures of the lighter kind are exceedingly grateful to the eye, from the intelligence and ease with which his pencil appears to have been conducted through all the various parts. Annibal Carracci, in a more bold manner, is also a master of great power in the execution part of the art; but he often appears to have laboured to express his thoughts; his works, however, possess great beauties of this nature.

In works of a different and smaller class from those produced by the masters whose names we have mentioned, almost the whole of the Dutch and Flemish schools are wonderfully skilful in their execution, particularly Rembrandt, Teniers, Janssen, Metz, Netscher, &c. and still more minute Gerard Dow, and Meins. In landscape, Cuyp, Berghem, Both, Ruysdael, and Hobbima, are all well worthy of the utmost attention in this respect; and many others, too numerous to be mentioned here, both of these and the Italian school, will greatly assist the student who attentively examines their productions to form his judgment, on those points wherein lie the greatest beauties of this necessary branch of the art of painting. But as a good execution consists in a free and ready hand, marking with fullness of precision and truth the characters of the objects represented; nothing but an intimate knowledge of nature will ever enable him to apply his observations on works of art to any beneficial purpose in completing the productions of his own imagination.

**EXECUTIONE facienda**, in *Law*, a writ commanding execution of a judgment.

**EXECUTIONE facienda in withernamium**, lies for taking the cattle of one who had formerly conveyed out of the county the cattle of another, so that the sheriff cannot replevy them.

**EXECUTIONE Judicii**, a writ directed to the judge of an inferior court, to do execution upon a judgment therein, or to return some reasonable cause wherefore he delays the execution. F. N. B. 20.

If execution be not done on the first writ, an *alias* shall issue, and a *pluries*, with this clause, *vel causam nobis significes quare, &c.* And if, upon this writ, execution be not done, or some reasonable cause returned why it is delayed, the party shall have an attachment against him who ought to have done the execution, returnable in B. R. or C. B. New. Nat. Br. 43.

**EXECUTIVE POWER**, *Supreme*, is by the constitution of these kingdoms lodged in a single person, the king or queen for the time being. See **CROWN** and **KING**.

**EXECUTOR**, a person nominated by a testator, to take care to see his will and testament executed or performed, and his effects disposed of according to the tenor of the will.

The testaments made in Latin, in the fourteenth century, call executors *provisores testamentarii*.

All persons are capable of being executors that are capable of making wills, and others besides, as feme-coverts and infants, and infants unborn; (West. Symb. p. 1. § 635.) but no infant can act as executor till he is seventeen years of age. This appointment of an executor, either by express words, or by such as strongly imply the same, is essential to the making of a will; (West. c. 1. Plowd. 281.) but if the testator names no executors, or names incapable persons, or if the executors that are named refuse to act, the ordinary must grant letters of administration. See **ADMINISTRATOR**.

A person appointed to be executor is not compellable to

execute the will; he may refuse the charge, before he has administered as executor, or performed such acts, as paying debts due by the testator, or receiving debts due to him, or giving acquittances for the same; but if he meddles with the goods of the testator, as executor, his subsequent refusal is void, and he shall be charged as executor. A person to whom a legacy is left may be compelled either to stand the executorship, or to resign his legacy. The refusal of executorship must be entered and recorded in court. If several executors are named in a will, and some of them refuse, and others prove the will, they who refuse may afterwards administer and act; and they must be joined in all suits, where the co-executors are plaintiffs; but not where they are defendants; because the plaintiff in the action is not bound by law to take notice of any besides those who have proved the will. Such joint-executors, though they are accounted in law but as one person, shall not be charged by the acts of their companions, any further than for effects *actually* come to their hands. (Moor. 620. Cro. Eliz. 318. 2 Leon. 209.) But if two or more executors join in a receipt (in writing) and one of them only actually receives the money, each is liable for the whole, as to creditors at law, but not as to legatees or next of kin. (1 Salk. 318.) If joint-executors, by agreement among themselves, agree that each shall intermeddle with a certain part of the testator's estate, yet each shall be chargeable for the whole (to creditors) by agreeing to the other's receipts. Hard. 314.

The interest, vested in the executor by the will of the deceased, may be continued and kept alive by the will of the same executor, so that the executor of A.'s executor is to all intents and purposes the executor and representative of A. himself. (Stat. 25 Edw. III. st. 5. c. 5. 1 Leon. 275.) But the executor of A.'s administrator, or the administrator of A.'s executor, is not the representative of A. For the power of an executor is founded upon the special confidence and actual appointment of the deceased; and such executor is therefore allowed to transmit that power to another, in whom he has equal confidence; but the administrator of A. is merely the officer of the ordinary, prescribed to him by act of parliament, in whom the deceased has reposed no trust at all; and therefore, on the death of that officer, it results back to the ordinary to appoint another.

As to the office or duty of an executor, it is to be observed that he may do many things before he proves the will, which an administrator cannot do; because the former derives his power from the will, and not from the probate or appointment of the ordinary, as the latter does. (Comyns. 151. Wentw. ch. 3.) He may maintain actions of trespass, replevin, or detinue; release an action, assent to a legacy, be sued, alien, or otherwise intermeddle with the goods of the testator: by administering, the executor is entitled to receive all debts due to the testator, and all payments made to him are good, though he should die, and never prove the will; but he cannot maintain a suit or action of debt, or the like, before he has proved the will. The ordinary, &c. may cite the executor, either to prove the will, or refuse the office; and he may sequester the goods of the deceased, till the executor has proved it; and if he does not appear on the process, the ordinary may excommunicate him. On the other hand, the ordinary is compellable by mandamus to proceed to probate, when the will is not controverted. The executor must bury the deceased in a manner suitable to the estate he leaves behind him; necessary funeral expences are allowed, previous to all other debts and charges; but if he be extravagant, he is chargeable with devastation, or waste of the substance of the deceased, which shall be only prejudicial to himself,

and not to the creditors or legatees of the deceased. (Salk. 196. Godolph. p. 2. c. 26. § 2.) He is then to make an inventory of all the goods and chattels, whether in possession or action of the deceased, which he is to deliver in to the ordinary upon oath, if lawfully required. He is then to collect all the goods and chattels so inventoried; for which purpose the law confers on him ample powers, as the representative of the deceased; (Co. Litt. 209.) and having the same property in his goods as the principal had when living, and the same remedies to recover them; and if there be two or more executors, a sale or release by one of them shall be good against all the rest. (Dyer. 23.) The executor must in the next place pay the debts of the deceased, in the order of their priority. See DEBT, and DEBTEE Executor.

Among debts of equal degree, the executor (and also the administrator) is allowed to pay himself first, by retaining in his hands so much as his debt amounts to. (10 Mod. 496.) If a creditor constitutes his debtor his executor, this is a release or discharge of the debt, whether the executor acts or not, (Plowd. 184. Salk. 299.) provided there be assets sufficient to pay the testator's debts.

If no suit has commenced against him, the executor may pay any one creditor in equal degree his whole debt, though he has nothing left for the rest; for, without a suit commenced, the executor has no legal notice of the debt. After the debts, the executor is to pay the legacies, which he is to pay as far as his assets will extend; but he may not give himself the preference herein, as in the case of debts. In case of a deficiency of assets, all the general legacies must abate proportionably, in order to pay the debts; but a specific legacy, as of a piece of plate, horse, &c. is not to abate at all, unless there be not sufficient without it. (2 Vern. 111.) If the legatees have been paid their legacies, and debts come in more than enough to exhaust the residuum, they are afterwards bound to refund a rateable part. (Ibid. 205.) See LEGACY, and DONATION *Causa Mortis*.

When all the debts and legacies are discharged, the surplus or residuum must be paid to the residuary legatee, if any be appointed by the will; if there be none, it was formerly understood to belong to the executor; (Perkins, 525.) but it seems to be now the general opinion, that, if there be an express legacy given to an executor, and no devise of the surplus, such surplus shall not go to the executor; but be disposed to the next of kin, according to the statute of distributions; the executor standing on the same footing as an administrator. (Prec. Chanc. 323. 1 P. Wms. 7. 544. 2 P. Wms. 338. 3 P. Wms. 43. 194. Stra. 559.) See INTESTATE.

Where no express legacy is given to the executor, the surplus shall go to the executor, and not otherwise disposed of by will. When there are several executors, and some of them are dead, the legatary must sue the surviving executors, and not the executors or administrators of those that are dead. And if all the executors are dead, he must sue the executors or administrators of those that died last, and not those of the rest.

By the French law, an executor should be seised of all the moveables of the deceased during one year; at the end whereof he is to account for them. To the validity of a testament, it is not necessary there be an executor nominated therein.

EXECUTOR *de son tort*, or of his own wrong, is he who takes on him the office of an executor by intrusion, not being constituted thereto by the testator or deceased, nor authorized by the ordinary to administer.

If an executor in his own wrong takes upon himself the

office of an executor, without lawful authority, he is chargeable to the rightful executor, and to all the creditors of the testator, and likewise to the legatees, so far as the goods amounted to, which he wrongfully possessed; and such an executor is made by any act of acquisition, transferring, or possessing himself of any of the estate or goods of the deceased; but not by acts of necessity, piety, or charity. (2 Nelson Abr. 793.) Such an executor cannot bring an action in right of the deceased; but actions may be brought against him; neither can he retain for his own debt or legacy. In case of his death, his executors or administrators are liable to the suit of the lawful executor, creditors, and legatees, by 30 Car. II. cap. 7.

EXECUTOR, *Debtee*. See DEBTEE.

EXECUTORY, that which has, or carries with it a sufficient authority for being executed.

EXECUTORY *contract*. See CONTRACT.

EXECUTORY *devise of lands*, is such a disposition of them by will that thereby no estate vests at the death of the deviser, but only on some future contingency.

It differs from a remainder (which see) in three very material points: 1. That it needs not any particular estate to support it. 2. That by it a fee-simple, or other less estate, may be limited after a fee-simple. 3. That by this means a remainder may be limited of a chattel interest, after a particular estate for life created in the same. The first case happens, when a man devises a future estate to arise upon a contingency; and, till that contingency happens, does not dispose of the fee simple, but leaves it to descend to his heir at law. As if one devises land to a feme-sole and her heirs upon her day of marriage; here is in effect a contingent remainder without any particular estate to support it; a freehold commencing *in futuro*. This limitation, though it would be void in a deed, yet is good in a will, by way of executory devise. (1 Sid. 153.) For, since by a devise a freehold may pass without corporal tradition or livery of seisin, it may therefore commence *in futuro*; because the principal reason why it cannot commence *in futuro* in other cases is the necessity of actual seisin, which always operates *in presenti*. And since it may thus commence *in futuro*, there is no need of a particular estate to support it; the only use of which is to make the remainder, by its unity with the particular estate, a present interest. And hence it follows, that such an executory devise, not being a present interest, cannot be barred by a recovery, suffered before it commences. (Cro. Jac. 593.) The second case happens where a deviser devises his whole estate in fee, but limits a remainder thereon to commence on a future contingency. As if a man devises land to A. and his heirs; but if he die before the age of 21, then to B. and his heirs; this remainder, though void in a deed, is good by way of executory devise. (2 Mod. 289.) But in both these species of executory devises, the contingencies ought to be such as may happen within a reasonable time; as within one or more life or lives in being, or within a moderate term of years; for courts of justice will not indulge even wills, so as to create a perpetuity, which the law abhors. (12 Mod. 287. 1 Vern; 104.) Thirdly, by executory devise a term of years may be given to one man for his life, and afterwards limited over in remainder to another, which could not be done by deed; for by law the first grant of it, to a man for life, was a total disposition of the whole term; a life estate being esteemed of a higher and larger nature than any term of years. (8 Rep. 95.) On this subject, see Blackst. Comm. vol. ii. p. 176, 8vo.

EXECUTORY *estate*. See ESTATE.

EXECUTORY *fine*. See FINE.

EXEDENS HERPES. See HERPES.

EXEDRÆ, Ἐξεδραί, among the *Ancients*, were places wherein the philosophers, sophists, rhetors, &c. used to hold their conferences and disputes.

M. Perrault is of opinion, the *exedræ* were a sort of little academies, where the men of learning met together. See ACADEMY.

Budæus rather thinks, that what the ancients called *exedræ*, might answer to what we call chapters in the cloisters of monks, or collegiate churches.

EXEGESIS, Ἐξήγησις, a term sometimes used by the learned, to signify *explication*.

Several interpreters of the Bible are of opinion, that in the passages of Scripture, where we meet with Abba Pater, two words, the first Syriac, and the second Greek or Latin, but both signifying the same thing; the second is only an *exegesis*, or explanation of the first.

EXEGESIS is also used for an entire discourse by way of explication or comment on any thing.

EXEGESIS *numerosa*, or *linealis*, signifies the numeral, or lineal solution, or extraction of roots, out of affected equations, first invented by Vieta. Ozanam calls it *la rhetique*. See EXTRACTION of roots.

EXEGETES, formed of ἔξηγηταί, *I explain*, among the Athenians, persons learned in the laws, whom the judges used to consult in capital causes.

EXEGETICA, in *Algebra*, the art of finding, either in numbers or lines, the roots of the equation of a problem, according as the problem is either numerical or geometrical. See ROOT and EQUATION.

EXELCOSIS, from ἕλκος, *an ulcer*, in *Surgery*, an incipient ulceration, or an excoriation, which is just beginning to suppurate.

EXEMPLAR, a model or original to be imitated or copied.

EXEMPLAR also denotes the idea or image conceived or formed in the mind of the artist, whereby he conducts his work. Such is the idea of Cæsar, which a painter has in his mind when he goes to make a picture of Cæsar. The exemplar is ordinarily numbered among the causes. See CAUSE.

EXEMPLIFICATION of *Letters Patent*, denotes an exemplar, or copy of letters patent, made from the inrolment thereof, and sealed with the great seal of England.

Such exemplifications are as effectual to be shewed, or pleaded, as the letters patent themselves.

EXEMPLIFICATIONE, in *Law*, is a writ granted for exemplification of an original record. Reg. Orig. 290.

EXEMPTION, a privilege, or dispensation, whereby a person is excepted out of some general rule.

Exemption is particularly applied to churches, chapels, and monasteries, which have a privilege given them by the popes, or princes, whereby they are exempted from the jurisdiction of the bishop or ordinary.

The council of Constance revoked all exemptions, to restore to the general-law, weakened and diminished by a relaxation of several ages, its ancient force and vigour, and make it every where obtain in all its latitude.

The council of Trent prohibited, and declared them null for the future; confirming only such as were well founded on legal concessions from the holy see.

EXEMPTION, in *Law*, denotes a privilege to be free from service or appearance; thus, knights, clergymen, &c. are exempted from appearing at the county courts by statute, and peers from serving on inquests. (6 Rep. 23.) Persons seventy years of age, apothecaries, &c. are also exempted

by law from serving on juries, and justices of peace, attornies, &c. from parish offices. 2 Inst. 247.

EXERCISE, a repetition of any operation, for the strengthening or retaining of a habit.

EXERCISE, or bodily motion, constitutes, in the language of the older physicians, one of the six *non-naturals*, and has been justly considered, from the earliest times, as an important measure in the preservation of health, as well as in the cure of several diseases.

The value of corporeal exercises in the estimation of the ancient physicians, from Hippocrates downwards, is manifest from their writings, in which the various kinds of exercise, as well as the degrees and times in which they are useful, are particularly discussed. Esculapius himself is said by Galen to have recommended riding on horseback, and other exercises, as the means of benefiting invalids. But Herodicus, a Thracian, seems to have been the first who paid serious attention to exercise, as a remedy for diseases. He was master of one of the academies, called *Gymnasia*, in which the military and athletic exercises were taught; and having remarked that his pupils usually enjoyed high health, he turned his attention to the regulation of the gymnastic exercises, with a view to attain or preserve good health; thus adding the *medical gymnastic art*, to the two others just mentioned. (See GYMNASTIC, and HERODICUS.) This master of the gymnasium, however, went to work empirically, and is accused by Hippocrates of doing considerable mischief, in attempting to cure febrile diseases by his exercises. (De Morb. Epidem. lib. vi.) Hippocrates and his commentator, Galen, have left many observations relative to the different exercises, and their particular effects in the alleviation of particular diseases. Friction, especially by means of the *strigil*, or flesh brush, is much inculcated; on which subject Galen has composed his second book, "De Sanitate Tuenda." The various modes of wrestling, the exercises of the *corycus*, or hanging ball, &c. are commented on by Hippocrates in lib. ii. De Diæta: and Galen wrote a little treatise *de parva pila*, (the little ball,) which he recommends as an exercise that influences both the body and the mind at the same time. In his discourse to Thrasibulus he discusses the question, whether the preservation of the health properly belongs to medicine, or to the gymnastic art: he inveighs against the athletic and other violent practices of the gymnasium, but approves of the more moderate exercises, which he considers as subservient to the purposes, and consequently a part of the art of the physician. Antyllus, and other Greek writers, have treated of the various exercises in the same light, as is evinced by the collections of Oribasius. (See Collect. Med. lib. vi.) The Romans even exceeded the Greeks in their attention to the medical gymnastics. Asclepiades, in the time of Pompey, as Pliny informs us, considered the different modes of exercise, *viz.* friction, walking, and gestation, as the chief auxiliaries of the physician, especially when combined with the proper regulation of diet; and by the employment of these exercises, the institution of baths, the invention of hanging beds, *lecti pensiles*, and other means of making physic agreeable, he is said to have acquired the general applause of all mankind: "universum prope humanum genus circumegit in, &c." (Plin. Nat. Hist. lib. xxvi. cap. 3.) Many eminent examples of the benefits of exercise among the Romans are on record. Suetonius states that Germanicus was cured of a sort of atrophy of the lower extremities, (*crurum gracilitas*) by riding. And Cicero himself, when reduced to a state of infirmity, which rendered it necessary for him to desist from pleading, recovered his health by travelling, and by excessive diligence in the use

## EXERCISE.

of friction. (Plutarch.) Friction was an exercise, indeed, reduced to a regular system among the ordinary habits of the Romans, and was preferred to a great extent by their physicians. See FRICTION.

That exercise, especially in the open air, is highly beneficial to the constitution, is a truth which universal experience has established. It is scarcely necessary, therefore, to appeal to the arguments of physiology to corroborate the proposition. It may be sufficient to state, that the immediate result of bodily exertion is an acceleration of the circulation of the blood; a quicker and stronger contraction of the heart, by which the blood is pushed more effectually to every part of the system, and especially through the small and extreme branches of the vessels. Hence a glow is produced on the surface, and the complexion assumes a redder hue, from the distention of the capillary vessels with blood; and the exhalent arteries begin to pour out the thinner portions of the fluids in perspiration. In the same manner, the extreme arteries of all the other parts of the body are distended, and excited to greater action; whence all the organs of secretion, which are principally made up of convolutions of the extreme arteries, are necessarily stimulated to an active performance of their several functions. The vessels of the stomach pour out the gastric liquors more abundantly, and the work of digestion is more perfectly and actively completed; the appetite for a new supply of aliment quickly returns, and the stomach is prepared for repeating the digestive process, by the increased supply of the digestive liquor. The liver and the pancreas, in like manner, elaborate their respective fluids, the bile and pancreatic juice, more copiously, and thus contribute an increased aid to the operations of the alimentary canal. The lungs, in the mean time, being called upon for an augmented supply of the vivifying principle derived from the oxygen of the atmosphere, by the increased circulation of the blood through them, respiration is increased in proportion to the quantity of venous blood which they receive. Thus, notwithstanding the greater rapidity with which the blood is carried to the secreting organs, it is rendered adequate to the secretion of the healthy fluids peculiar to each, by the increased operation of the lungs; as well as to the support of the greater muscular action, in which the exercise consists.

It must be obvious, then, that this general activity of the whole system, this free circulation through the most minute ramifications of the vessels, and through the glands and organs which they compose, and this prompt separation of the excrementitious and other parts of the blood, by the secretions, cannot but contribute to the general health of the body. It is not less obvious that it contributes to the evolution and growth of the different parts of the body; whether we consider the great influx of the blood, from which all growth is derived; or observe the fact, that those muscles and limbs, which are most actively exercised, invariably acquire superior bulk, as well as superior strength. The muscles of the arms in blacksmiths, and those of the loins in porters, and all others employed in raising or carrying great weights, invariably acquire a disproportionate size; and, on the contrary, those muscles which are little employed are apt to shrink, and to be comparatively enfeebled, as in the legs of tailors. The effect of exercise in giving strength and rigidity of fibre to the muscular or fleshy part of animals is well known, and daily exemplified in the difference of texture in the wings and legs of birds which we use as food. In the common fowls, which seldom use the wing, and constantly employ the legs in walking, the hardness of the flesh of the latter, and tenderness of that of the former, are notorious. From this influence of exercise in con-

tributing to the growth and strength of the animal body, we may obviously trace the final cause of that instinctive disposition to activity and motion, which the young of all animals possess.

Regular exercise, not too violent in degree, nor continued too long, so as to induce excessive fatigue, is therefore to be considered as the most important preventive of diseases. It is not easy to lay down rules by which it should be regulated; since the constitution, age, strength and habits must modify its effects in different individuals. A sudden transition from a state of rest to violent exertion is injurious to the invalid, especially after a full meal, or if continued until a profuse perspiration, or great lassitude takes place; for this over-exertion necessarily leads to a languor and imperfect performance of all the vital actions, every organ partaking of the general fatigue. The various kinds of exercise may be considered under two classes, the active and the passive; the former being the result of our own muscular activity, such as walking, dancing, running, swimming, fencing, the military exercise, and different athletic games; the latter the result of communicated motion, as riding in a carriage, sailing, swinging, friction, &c.; riding on horseback, or driving a carriage, partakes in some measure of both the active and passive exercises.

Walking, which seems to be the most natural exercise, is capable of producing all the effects above detailed, if adapted in degree and duration to the various circumstances. Hence the most obstinate cases of hypochondriacal disorders, of indigestion, and other stomach complaints, have been frequently removed by perseverance in walking, especially in the open air of the country. But when the exercise of walking is adopted with a view to banish the complaints just mentioned, which a sedentary life is apt to induce, it is most effectual when regularly and strenuously pursued. That degree of walking, which, when resorted to occasionally, or with considerable intermissions, produces great fatigue and languor, and therefore is rather prejudicial than advantageous, would, if daily continued, soon cease to fatigue, and would then contribute greatly to restore the healthy state of the functions. It must be recollected that the animal vigour is consumed, or, to use the language of Brown, the excitability is exhausted, by the mental functions as well as by muscular exertion; therefore, to carry with us, in our walks in search of health, the brooding anxieties and cares of our professions,—to attempt to combine study with such exercise by reading, or by serious reasoning in conversation, is to thwart the good effects of the plan. We may observe that, so incompatible is deep thought with muscular exertion, that most people stop in the midst of their activity, when their arguments require great reflection. Serenity of mind, and a relaxation from the serious occupations of life, are therefore necessary, when walking is resorted to as a remedy.

Of the more violent species of active exercise, which can only be resorted to as a preservative from disease, by those who are in a state of good health, it is unnecessary to speak.

The modes of exercise which are particularly useful in the cure of diseases, or in the restoration of the health of convalescents, are the different species of gestation, especially riding in carriages, or on horseback, and sailing.

The motion of a ship produces the most gentle exercise, and is therefore adapted even to the relief of very infirm conditions of the body, and it has been employed from early times in the cure of consumption. The Romans, in the time of Pliny, used to send their consumptive patients to Egypt; not, as that author takes care to inform us, on

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account of any peculiarity of that country, but in consequence of the length of the voyage. *Annaeus Gallio*, who had been consul, was cured of a consumption by such a voyage. (*Nat. Hist. lib. xxxi. cap. 6.*) *Celsus* seems to have considered sailing, when resorted to early, as the principal remedy for consumption: "opus est, si vires patiuntur, longa navigatione," he says; and where the strength is not equal to it, he recommends short voyages, or the use of a litter, or other means of gentle gestation. (*De Medicina, lib. iii. cap. 22.*) The advantages of a sea voyage, especially to a warmer climate, are well known to modern physicians; and instances of the success of such a voyage to *Madeira*, *Lisbon*, &c. when undertaken in the incipient stage of consumption, as *Celsus* recommends it, are very numerous. This, however, like all other remedies for consumption, is too often resorted to when the disease has already advanced too far to admit of any effectual relief. See CONSUMPTION.

The exercise of gestation by means of a carriage, and the more active exercise of riding on horseback, being more easily obtained, are of more importance in our consideration of the subject. Horseback exercise was not much adopted by the ancients, with a view to the cure of diseases; partly because that valuable animal was less used by the Greeks and Romans, and partly because their mode of riding, without stirrups, was incompatible with the weakness of invalids. (See *Fuller, Medicina Gymnastica, p. 231.*) Hence we may understand the observation of *Antyllus*, that "riding is of little use to those who are sickly, because a slow pace is productive only of lassitude, especially in the loins;" he admits, however, that "a quick pace of the horse, although it occasions a troublesome shaking of the whole body, is nevertheless somewhat beneficial, and strengthens the system, especially the stomach and the organs of sense, more than all other exercises." (*Oribasius, loc. cit. lib. vi. cap. 24. de Equitatione.*) The great advantages of riding in the prevention and cure of many diseases are insisted upon in the strongest terms by *Sydenham*, who, indeed, appears, in several parts of his writings, to have considered it as a remedy of inestimable value, provided it be persevered in with constancy, in the manner which we have inculcated in respect to walking. Speaking of the mode of cure in chronic diseases, that sagacious physician observes, "nothing, among all the expedients which have hitherto come to my knowledge, so effectually supports the spirits and strength, as long and constant riding on horseback." (*Diff. Epistolaris.*) Again in his *Treatise on the Gout*, and particularly respecting the prevention of the paroxysms by exercise, he says, "riding on horseback is far preferable to all other exercises for this purpose; in truth I have frequently considered, that if any person were acquainted with a medicine, which he chose to keep secret, of equal efficacy in this, and in the greater number of chronic diseases, with a constant and persevering exercise on horseback, he would speedily accumulate the most ample wealth." And to express his full conviction of the value of this exercise in consumptive complaints, he uses these strong terms: "in short, however fatal consumption is deemed to be, and actually is, since it destroys two thirds of those who die of chronic diseases, yet I solemnly affirm, that neither is mercury a more effectual remedy for the lues venerea, nor Peruvian bark for agues, than is the exercise just commended for consumption, provided that the patient be always careful to sleep in dry linen, and that his journey be sufficiently long." The truth of this great encomium is indeed questioned by modern practitioners in general, however weighty the authority of *Sydenham* may be. But there are many cases on record,

which seem to justify this observation. Witness the case of the late *Dr. Currie*, of *Liverpool*, as related by himself, in the *Zoonomia* of *Darwin*. (*Vol. ii. class. ii. Ord. i. 6.*) In this case, the patient had an hereditary predisposition to consumption, and was restored by travelling from a state of debility, in which the erect posture could scarcely be borne without fainting, to good health; having begun with the exercise of a carriage, and afterwards ridden on horseback, as his strength augmented. *Sydenham* has related several examples of the value of this exercise, and others may be found detailed by *Fuller*, &c. We cannot therefore doubt, that in many instances, in which it has seemed to be destitute of the efficacy ascribed to it by *Sydenham*, the failure must be attributed to the imperfect or too late use of the remedy. "I must here repeat," says *Fuller*, quaintly, "that when I speak of riding, I understand the habit of riding, the want of which distinction has made it ineffectual to many a man. He that in this distemper (consumption) above all others rides for his health, must be like a Tartar, in a manner always on horseback; and then from a weak condition he may come to the strength of a Tartar." (*Medicin. Gymnast. p. 106.*) We have dilated upon this topic, from a conviction that many chronic diseases, which are included under the epithets of bilious and nervous, as well as many morbid conditions of the viscera, for which drugs, and even the waters of *Bristol*, *Bath*, and *Cheltenham*, are ineffectually swallowed, might be removed by a steady and unremitting exercise, in a carriage, or still more certainly on horseback.

It is unnecessary to enter into a particular enumeration and discussion of every possible form of exercise, the principle being the same with respect to all. A late intelligent writer has laid down some useful practical precepts on these topics, mixed with a good deal of trifling observation, and absurd hypothesis. (See *Willich's Lectures on Diet and Regimen, chap. 7.*) The following remarks on the injuries occasioned by want of exercise are from that popular writer.

"We are now to consider the consequences arising from want of exercise. This, indeed, is still more debilitating than too violent motion. The solid parts of the human frame are relaxed by it; the circulation of the fluids is retarded; they gradually stagnate in the smaller capillary vessels; the secretions are diminished; and abundance of moisture or fat is generated, which renders the body, as well as the mind, more indolent and lethargic, relaxation of the muscles, obstructions of the intestines, hemorrhoids, apoplectic fits, various species of dropsy, and at length a premature death, are the sad consequences. Men of letters are the most unhealthy of all human beings, because their bodies have scarcely any other exercise but the imperceptible motion of the arms. Want of appetite, flatulency, anxiety, at one time obstructions, at another diarrhœa, and the most diversified nervous symptoms are their attendants. Sleep is beyond their reach; a thousand tormenting inconveniences, hypochondriasis, and at length a complete state of melancholy, is too frequently their lot. Temperance alone will not remedy all these evils; for, since we cannot remain vigorous and healthy for two days together, with the same mass of blood, a new access of the newest and most subtle parts of our fluids must daily support the nervous system, in order to preserve its regular functions. If this be not continually restored, weakness and relaxation of body and mind are the inevitable consequences; with this difference only, that in a state of debility from too much bodily exercise, the thick and coarse particles of the fluids are carried into circulation with the others, and the next meal or the first sleep after it, soon

soon supplies the deficiency in mental labour; on the contrary, digestion is interrupted, the crude and viscid parts of food remain unassimilated, and the body is prevented from receiving proper nourishment. In like manner sedentary mechanics and artificers are affected, particularly shoe makers, tailors, and weavers. They experience maladies similar to those to which men of letters are subject; and it has been frequently observed, that they are very liable to diseases of the mind, and especially to religious fanaticism."

**EXERCISE, Field, in Military Affairs,** relates to the evolutions performed by companies, regiments, or greater bodies of troops, when learning, or practising, those movements necessary to be correctly understood by persons of all ranks in the military profession. See **EVOLUTIONS** and **TACTICS**.

**EXERCISE, Gun,** relates to the several arrangements, and motions, made for serving either heavy or light artillery, under every circumstance common to military operations. See **GUN-Exercise**.

**EXERCISE, Manual,** teaches the several motions of the firelock, whereby all act as it were in unison, and perform their duties when drawn up for display, or for service, in an uniform and appropriate manner. See **MANUAL-Exercise**.

**EXERCISE, Sword,** refers to the several positions of the sword, adapted either for attack, defence, or compliment. See **SWORD-Exercise**.

**EXERCISE, in a Naval Sense,** is the preparatory practice of managing the artillery and small arms, in order to make the ships' crew perfectly skilled therein; so as to direct its execution successfully in time of battle. The words of command introduced, during the late war, for the exercise of the great guns, are the following: "Silence: cast loose your guns; level your guns; take out your tompions; run out your guns; prime; point your guns; fire; sponge your guns; load with cartridge; shot your guns; put in your tompions; house your guns; and secure your guns. Falconer's Marine Dict. art. *Exercise*."

Exercise may also denote the execution of the movements, which the different orders and dispositions of fleets occasionally require, and which the several ships are required to perform, by means of signals.

**EXERCISES,** in the plural, are particularly understood of what is taught young gentlemen in the academies, or riding-schools, &c. As riding the great horse, dancing, fencing, vaulting, drawing fortifications, &c.

**EXERGASIA, Εξεργασία, Exposition, in Rhetoric,** a figure consisting of several equivalent expressions, or such as are nearly so, in order to represent the same thing in a stronger manner. The warmth and vehemence of the speaker often urge him to recur to this figure, when he is affected with his subject, and there are no words, no expressions, sufficiently forcible to express his sentiments; and he therefore repeats one after another, as his fancy suggests them. This flow of expression, under the conduct of a good judgment, is often attended with advantage; as it warms the hearers, and impresses their minds, excites their passions, and enables them to see things in a stronger light.

**EXERGUM, EXERGUE, or Exerge,** often denominated by Evelyn *exurge*, among *Medalists*, is the bottom of a coin, commonly separated from the field by a line, upon which the figures of the reverse stand. It is so called from being *εξ εργου*, out of the work of the medal. When the letters or words of a medal run round the margin, are on either side of the figure, or upon the exerge, they are denominated a *legend*; but when they occupy the field, they are called an *inscription*. See **LEGEND** and **INSCRIPTION**.

**EXETER, in Geography,** a city in Devonshire, England is of great antiquity, and, as Risdon emphatically styles it "may be called the emporium and principal ornament of the west." Its Roman name, as it appears in Ptolemy, is *Isca*; and it is conjectured that the second legion of Augustus was stationed here for some time: this was commanded by Vespasian, who was the conqueror of Britannia Prima, in which province this place was included. In the Itinerary of Antoninus, Exeter is called *Isca-Danmoniorum*, and is the most westerly station he has noticed: though, from the Iters of Ptolemy and Richard; from the remains of Roman roads over, and around Haldon; and from the vestiges of ancient ways through Drew-Teignton to Oakhampton, and perhaps of a road hence over Dartmoor, by Hollow-treet in the parish of Clagford; it is apparent that various principal roads ran westward from this city; and, therefore, it is probable that the Romans had other stations west of this. How long Exeter retained the name of *Isca-Danmoniorum* is uncertain; though it seems probable that it fell into disuse very soon after the Romans quitted the island, about which time it appears to have been re-occupied by the Britons who had preserved their independence by retiring to the wilds of Cornwall. They did not, however, continue in the possession of it many years; for Cerdic, the founder of the kingdom of Wessex, having greatly extended his territories, either by conquest or intrigue, included the most considerable portion of Devonshire within his dominions: and at length Exeter became subjugated to the power of the Saxons. Under their government its name was changed to *Evan-Cestre*, *Ex-Cestre*, &c., and thence, through various similar appellations, softened to Exeter.

This city has been several times besieged; but the greatest calamities it experienced were inflicted by the Danes, who, in the reign of Alfred, in violation of a solemn treaty, surprised and routed the king's horsemen, and mounting their steeds, rode to Exeter, and remained there for the winter. Alfred collected all his forces and invested the city by land, while his fleet blocked up the harbour: the Danes capitulated, and agreed to evacuate all the territories of the West Saxons. Between the period of the death of Alfred and the reign of Athelstan, the Cornish Britons had recovered possession of Exeter; but Athelstan having defeated and driven them to the west of the Tamar, they were never afterwards able to oppose the Saxon arms. To secure his conquests he surrounded Exeter with a wall of hewn stones defended by towers: and under his auspices, says Malmesbury, "it became such a place of trade, that it abounded with opulence." He adds that many other remarkable works of Athelstan were to be seen in the city and its neighbourhood. In the year 1003 Exeter was the first sacrifice to the fury of Swein king of Denmark, when he came to revenge the inhuman massacre of his countrymen: being delivered up by the treachery of its governor, after a siege of two months, many of the inhabitants were put to the sword, and most of the buildings destroyed by fire. Before it was well recovered from this calamity, it was again besieged and taken by William the Conqueror. In the reign of Stephen, this city was alternately garrisoned by the forces of the king and the empress. It again became the scene of hostility during the contest between Henry VI. and Edward IV. In the reign of Henry VII. it was closely, though ineffectually, besieged by three thousand men under Perkin Warbeck. The last siege Exeter experienced was in Edward VI.'s reign, when religious innovations occasioned an alarming insurrection in the west of England: the inhabitants, though reduced nearly to famine,

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so bravely defended the city for thirty-five days, that the insurgents abandoned their design.

The ground inclosed within the walls of the city is nearly in the form of a parallelogram, of four furlongs in length, and three in breadth: this space is intersected by the four principal streets which meet near the centre, and diverging at right angles, connect the city with the suburbs. The whole extent occupied by buildings is about one mile and three quarters in length, and one mile in breadth. In the year 1769 the surrounding walls were entire; but many parts have been since destroyed. Stukeley speaks of them as being, in his time, in pretty good repair, and having many turrets and towers, various parts of which are still remaining. Leland, speaking of this city, observes, that it is "a good mile and more in compass, and is right strongly waulid and maintainid. Ther be diverse fair towers in the toune waul bytwixt the south and the west gate. Ther be four gates in the toune, by the names of est, west, north, and south. The est and the west gates be now the fairest, and of one fascion of building: the south gate hath bene the strongest." In the year 1769 the north gate was taken down, to make a more convenient entrance into the city; and in 1784 the east gate was removed for the same purpose. The south gate, the interior arch of which Dr. Stukeley remarks to be of Roman workmanship, is intended to experience the same fate.

The situation of Exeter is commanding and pleasant: it stands on the acclivity of an eminence on the eastern banks of the river Exe, which flows in a semi-circular direction round the south-west side of the city. "What adds to its wholesomeness and cleanliness," says Stukeley, "is, that the ground is higher on a ridge along the middle of its length declining on both sides. Further, on the south-west and north-west sides it is precipitous; so that with the river, the walls, the declivity of ground, and ditch without side, 'twas a place of very great strength, and well chose for a frontier." In the highest part of the city, on the north side, stand the remains of Rougemont castle, which was formerly the seat of the West Saxon kings, and afterwards of the dukes of Exeter. This building has little to recommend it but its antiquity and pleasant situation. The ruins of the exterior walls are nearly all that remain; these inclose a considerable space, of a pentagonal form, and were defended by four towers; two on the west, and two on the east side. The ramparts of the castle command a most delightful view over the adjacent country. When the castle was erected is unknown; though Grafton's tale, that it was built by Julius Cæsar, is unquestionably false. William the Conqueror either rebuilt, or much repaired, the whole edifice, and bestowed it on Baldwin de Brion, husband of Albreda his niece, whose descendants, by the female line, enjoyed it, together with the office of sheriff of Devon, which seems to have been annexed to it, till the fourteenth year of Henry III.'s reign, when that prince, resuming into his own hands sundry castles and forts in this realm, dispossessed Robert de Courtney, in whose family it had been for three descents. In the civil war of the seventeenth century the castle was completely ruined, when the city withstood a blockade of two months against Fairfax, one of whose forts, Mr. Gough says, still remains in a field to the north. Within the area inclosed by the walls, a small chapel was erected by lady Elizabeth de Fortibus, countess of Devon, who endowed it with lands, called the prebends of Hays and Catton, for the payment of certain weekly services therein to be performed. A sessions-house, of Portland-stone, has been recently built within the area on the north-west side.

Within the walls of the city are fifteen parish churches, and in the suburbs four; but most of them being small, they present nothing worthy of particular description.

The cathedral is a large interesting edifice, and, according to Hooker and some other writers, was five hundred years in building; it consists of a nave with two aisles, a choir with aisles, a north and south transept, which are terminated by lofty towers. On the south side was a large cloister, which is mostly destroyed. To the east of this is the bishop's palace, which, with its gardens, are inclosed within a lofty wall. For a particular history and description with several architectural points, see a large folio work published by the Society of Antiquaries.

The episcopal see of Devon was seated at Crediton previous to its establishment at Exeter; but Leofric, who was bishop of that see, and lord chancellor of England, prevailed on Edward the Confessor to remove it to the latter town in the year 1049. That monarch, in person, with Eadýga, his queen, attended the installation, and placed the bishop in his new see; which at the same time he endowed with the lands and emoluments appertaining to that of Crediton. The see being thus established, it appears probable that a suitable cathedral was soon afterwards erected: but whether it was constructed by the enlargement and alteration of some existing edifice, or whether a separate and entire building was now raised, is uncertain. "It seems not unlikely," observes sir Henry Englefield, "that the first cathedral was not more than about sixty feet in length, and occupied the site of the present chapel of St. Mary." That the chapel, in its present state, was not the Saxon church, is satisfactorily proved by an examination of its architecture. No particular alteration appears to have been made in the cathedral before the time of William Warlewast, the third bishop, who was a Norman, and had been chaplain to the Conqueror, and his two sons, William and Henry; the latter of whom inducted him to this see in 1107. This prelate was a liberal benefactor to his cathedral; and it appears that he considerably enlarged it, and laid the foundation of the present choir: to him the towers yet remaining are probably to be ascribed; they are perfectly similar in style to the buildings of Gundulphus his cotemporary, and bear much more resemblance to the magnificence of the Norman architects, than to the simplicity of the English Saxons.

Exeter has been from time immemorial, and still is, invested with great privileges. At the period of the Norman survey it enjoyed the same exemption from taxes as London, York, and Winchester. Since that time it has obtained many charters, and grants of immunities, from several monarchs. In the reign of Henry I. the fee-farm rents were granted to Matilda his queen; and in king John's time, Isabel, his consort, held Exeter in dower, with a fair thereunto belonging. In the third year of John's reign, the burgesses paid a fine of 110 marks for a confirmation of their charters; and about this period the city, which had been previously governed by port-reves and bailiffs, was incorporated, and had a mayor for its chief officer. We find in the *Notitia Parliamentaria*, that "in the reign of Edward I. the burgesses and citizens pleaded that their city was an ancient demesne, and that they held it in fee-farm of the crown, paying 39*l.* 15*s.* 3*d.* To support this claim, they referred to Henry III.'s charter, made to his brother Richard, king of the Romans; whereby they further challenged return of writs, a gallows, pillory, &c. and a fair of four days, besides three weekly markets; which liberties they certified they enjoyed since the time of the conquest; upon which they were allowed." Henry VIII. constituted

constituted Exeter a county of itself; thus rendering it independent of Devon, and investing it with corresponding privileges.

The corporation now consists of a mayor, twenty-four aldermen, a recorder, chamberlain, town-clerk, sheriff, four stewards, and several inferior officers. The corporate bodies within the city are thirteen, each of which is governed by officers annually chosen from among themselves. Exeter was one of the first cities that returned members to parliament: the right of election is vested in the magistrates and freemen, who are supposed to amount to about one thousand persons. The trade of Exeter is extensive; yet would probably have been much more so, but for a contention between the inhabitants and Hugh Courtenay, earl of Devon, which deprived the city of the use of its river for navigable purposes during several centuries. The dispute is reported by Izacke to have arisen about some pots of fish; which, being exposed for sale in the market place, were seen nearly at the same time by the caters of the earl, and of the bishop of Exeter, both of whom wanted the whole. The mayor, to whom the difference was referred, adjudged one part to the earl, another to the bishop, and the third he directed to be kept for the use of the market. This decision, and a subsequent determination of the mayor and council, that no freeman of Exeter should wear any foreigner's livery, badge, or cognizance without the mayor's licence, offended the earl, who immediately impeded the navigation of the river, "stopping, filling, and quirting the same," says Hooker, "with great trees, timber, and stones, in such sort, that no vessel, or vessels, could pass or repass." Previously to this occurrence the tides flowed beyond the city; but now they only reach Topsham, a town between three or four miles nearer the sea, the advantage of which was probably the chief object of the earl's measures, as that place was part of his estate, and became exceedingly flourishing in consequence. The river was so completely choaked up, that though many attempts were made to restore the navigation, scarcely any thing was accomplished till the year 1675, when a canal was cut from Topsham to the city; and about twenty years afterwards the present haven was constructed: and by means of sluices and flood-gates, vessels of 150 tons burthen are now admitted to a good quay, formed near the city walls.

Exeter is situated 170 miles W. from London. The number of inhabitants, as returned under the late act, was 17,388; of houses 2836. The principal employ of the labouring classes of people arises from the woollen trade; and the city has derived immense profits from the exportation of serge, kerseys, and other articles, the value of which together has been computed at the average sum of 600,000*l.* per annum: the chief markets were, during peace, Spain, Portugal, Germany, and Italy. About 300 persons are also employed in manufacturing cotton, at a large factory established on the banks of the river. Exeter had anciently a mint, which was granted by king Athelstan; and money has been coined here so late as the reign of William III., the place of coinage being denoted by the letter E under the bust.

This city has been the birth place of several very eminent and learned men. Among the most distinguished are, Josephus Iscanus, whose writings adorned the commencement of the thirteenth century: John Hooker, sir William Petre, and sir Thomas Bodley, who all flourished in the sixteenth century; and sir Peter, afterwards lord King, who held the high office of lord chancellor from 1725 to 1733.

In the vicinity of Exeter are several handsome, and re-

spectable seats, belonging to the nobility and gentry. The principal of these are, Powderham-castle, belonging to viscount Courtney; Mannhead, the seat of lord Luburne; Haldon-house, the seat of sir Lawrence Palk, &c.; Mount-Radford, the seat of John Baring, esq.; Peamore, the seat of Samuel Kekewich, esq.; Cleve, the seat of Thomas Northmore, esq.; Cowicke, the seat of James White, esq.; Oxtou-house, the seat of the Rev. John Swete. Polwhele's History of Devonshire, 8vo. Jenkins's History and Antiquities of Exeter, 12mo. 1806.

EXETER, a post-town of America, in the county of Rockingham and state of New Hampshire, and, Portsmouth excepted, the most considerable sea-port town in the state. It is situated on the head of the navigation on Swamscot; or Exeter river, a branch of the Piscataqua, 15 miles S.W. of Portsmouth. The tide rises here eleven feet. This town is well situated for manufactures, and has already six saw mills, a fulling mill, flitting mill, paper mill, snuff mill, two chocolate and ten grist mills, iron-works, and two printing offices. The sallery business is very considerable. Some few vessels of different burden are built here, and the river is capable of floating those of 500 tons. The situation of Exeter is adapted for an extensive population. The public edifices are, two congregational churches, an elegant building appropriated to the academy, a handsome and capacious court-house, and a gaol. The public offices of the state are at present kept in this place. It contains 1727 inhabitants. The township is of an irregular figure, and about four miles square. It was incorporated in 1638, before which period it was called Swamscot falls; it lies 50 miles N. of Boston. N. lat. 42° 59'. W. long. 71°. The academy was founded and endowed by the Hon. John Phillips, L.L.D. of Exeter, and incorporated by act of assembly in 1781. It is said to be a respectable institution, under the inspection of a board of trustees, and the immediate government and instruction of a preceptor and an assistant. Its annual income is 480*l.* and the number of students is commonly between 60 and 80. In 1794 a building was erected, which, in point of convenience, and perhaps of elegance, is exceeded by few buildings of the kind in the United States. Morse.

EXETER, the north-westernmost township in Washington county, and state of Rhode island, in which the several branches of Wood river unite; containing 2476 inhabitants, of whom 24 are slaves.—Also, a township in Luzern county, Pennsylvania, including 737 inhabitants.—Also, a town in New Hanover county, in Wilmington district, North Carolina; situated on the N.E. branch of Cape Fear, about 36 miles from Wilmington.

EXFOLIATION. This term, in *Surgery*, denotes the process by which the dead part of a bone separates from the living portion. It is also not uncommon for surgeons to signify, by the word *exfoliation*, the piece of bone itself that has perished, though this is certainly an abuse of language.

Exfoliation, or the separation of a dead portion of bone from the living, is effected much in the same way as a slough is thrown off from the soft parts. The piece of bone which has perished is not detached by becoming rotten; for, in fact, it possesses considerable firmness, and at first coheres as intimately as ever to the living bone immediately contiguous to it. As Mr. Hunter has accurately observed, if the process of exfoliation were not to take place, the dead piece of bone would remain undetached for years, inasmuch as putrefaction is concerned in producing the separation.

The more the pathologist considers the diseases of the bones

## EXFOLIATION.

bones, the more he will find them resemble those of the soft parts. This fact, indeed, anatomy would lead one to infer, since the texture of the bones is the more similar to the structure of the rest of the body, than an uninformed person would suppose. The chief difference is, that the bones contain lime, which the soft parts do not.

Mr. Hunter describes the process of exfoliation as follows; a dead bone (he says) acts on the system in the same manner as any other extraneous body. It stimulates the adjacent living parts, in consequence of which such a process is begun, as must end in the dead piece being thrown off. The effects of this stimulus are; first, that the living adjacent bone becomes more vascular, a circumstance which always takes place, when a part has more to do than is just sufficient for the support of life. Secondly, that the earth of the living part, when it is in contact with the dead bone, is absorbed. Hence the bone becomes softer, and is now only adherent by the animal matter in its texture. Thirdly, that the living animal part is at last absorbed along the surfaces of contact. This part of the process begins long before the last is finished. Both of them begin first at the surface, though, in their course, they do not every where take place, in an equal degree, at the same time. Fourthly, that, in proportion to the waste made by the last part of the process, a fungus arises from the living surface, and fills up the intermediate space, so as to prevent a vacuum. Mr. Hunter observes, that these different stages, taken together, constitute ulceration. He remarks, that when any part of a bone is once loose, it will be pushed towards the surface of the body, as most other inanimate substances are. This part of the process is partly mechanical, and partly a continuation of ulceration. The same distinguished surgical writer also notices, that a proof of the third stage above mentioned, may be derived from certain cases, in which people die while exfoliation is going on. A small groove, or worm-eaten canal, may then be discovered, which becomes gradually deeper, and follows the irregularities of the dead and living surfaces. After the application of the trepan, a circular piece of bone is frequently thrown off, which is always less than the space from which it came. This, says Mr. Hunter, could never be the case, if there were not a loss of substance.

Thus we find that exfoliation, and the process by which a slough of the soft parts is detached, are nearly alike. In both instances, the matter which forms the bond of connection between the dead and living substances, is absorbed, the dead part is loosened, and is next pushed off by the rising of the granulations.

The bones, on which exfoliations most frequently occur, are such as are of a firm, solid structure; those which are of a spongy cellular texture, are more subject to the affection called caries.

All the old surgical practitioners and writers used to promulgate the doctrine, that whenever the surface of a bone was laid bare, and deprived of its periosteum, an exfoliation must inevitably follow. The practice, which was resorted to in consequence of this notion, did really, for the most part, occasion a destruction of a part of the bone, and the progress of the case seemed a confirmation of the erroneous opinion, resting on experience itself for its foundation. For it followed almost as a matter of course with the ancient surgeons that since they considered the occurrence of exfoliation unavoidable in the circumstance which we have mentioned, their grand aim was to promote and accelerate the process, so as to shorten, as they conceived, the duration of the case. With this view, they used to put on the uncovered part of the bone stimulating, drying, spirituous applications, and,

very often, the actual and potential cautery. Also, fancying that the wound could never heal till the dead piece of bone had come away, they used to avoid laying down the flesh, so as not to leave the surface of the bone a long while exposed, a cause, of itself, quite adequate to the production of an exfoliation.

However, the fact is, that a mere temporary exposure of part of a bone, such a transient denudation, as need only be permitted in cases of wounds, is not necessarily, or even commonly followed by an exfoliation, when a proper method of treatment is pursued.

We have already remarked that the diseases of the bones are more like those of the soft parts, than many would imagine. The exposed surface of a bone will not die, if it be otherwise free from injury, and the surgeon, immediately he is called, take care to lay down the detached flesh in the situation which it previously occupied. Even when the denuded bone, on account of loss of substance, cannot be directly covered again, it will not always exfoliate, provided the surgeon, instead of using the cautery, caustics, spirituous, or any other irritating applications, applies only some plain soft lint, or a pledget of any mild simple ointment.

When the soft parts are merely divided, the exposed surface will not slough; but when the wound is complicated, with a violent degree of contusion, laceration, &c. the case is different, and the fibres, vessels, &c. most injured, will die and be thrown off. These parts may either be killed at once by the violence, or the mischief which they have sustained may give rise to inflammation, which may terminate in sloughing. Things are nearly the same with respect to the bones. We will bring to our consideration a few circumstances relating to the subject of wounds of the head, which are, perhaps, more frequently than any other kind of wounds followed by exfoliations. In these instances, if the soft parts be simply cut, so as to occasion an exposure of the cranium, without the bone itself being violently contused, the wound may be healed by the first intention, and no part of the skull will exfoliate. The same occurrences may happen, together with a detachment of the pericranium, and yet the same consequences will follow.

However, when the external violence has affected the bone, as well as the soft parts, the injured part of the skull will frequently die and exfoliate, notwithstanding the most judicious treatment.

The process by which an exfoliating piece of bone is thrown off, depends almost entirely upon nature, and the surgeon can interfere very little, with any real utility. The milder and less irritating his dressings are, the better. Sometimes, when the dead part of the bone is loose, but is so covered with flesh that it cannot come away, the practitioner may greatly expedite the cure, by making a proper opening for the removal of the piece of bone that has exfoliated. Sometimes, when the process of exfoliation is long and tedious, he may render essential aid by occasionally introducing a pair of small forceps into some sinus leading down to the affected bone, and moving the exfoliating portion a little every now and then, so as to accelerate its separation. This latter proceeding, it is obvious, is only admissible when the opening in the soft parts is large enough, and when the dead piece of bone either projects, or is of such a shape as will allow of its being taken hold of with a pair of forceps. Sometimes, when the dead piece of bone is prevented from exfoliating, by being overlapped by new osseous matter at its circumference, the surgeon may properly make some attempt to cut away the portion which is so wedged, that its spontaneous detachment would require an unreasonable length of time. Endeavours of this kind, however, on the

part of the surgeon, should be made with great circumspection and prudence; and, indeed, they can only be justifiable when the affected bone is sufficiently superficial.

**EXFOLIATIVUM**, from *exfolio*, to *shed the leaf*, an instrument for scraping exfoliating bones.

**EXFREDIARE**, in our *Old Writers*, denotes the breaking of the peace, or committing open violence. Leg. Hen. I. cap. 31.

The word is formed from the Saxon, *frede*, peace.

**EX GRAVI QUERELA**, in *Law*, a writ that lies for him to whom any lands or tenements in fee are devised by will (within any city, town, or borough, wherein lands are devisable by custom), and the heir of the devisor enters, and detains them from him. (Reg. Orig. 244. Old Nat. Br. 87.) And if a man devises such lands or tenements unto another in tail, with remainder over in fee, if the tenant in tail enter, and is seised by force of the entail, and afterwards dieth without issue, he in the remainder shall have the writ, *ex gravi querela*, to execute that devise. (New Nat. Br. 441.) Also where a tenant in tail dies without issue of his body, the heir of the donor, or he who hath the reversion of the land, shall have this writ in the nature of a *formedon in the reverter*. Ibid.

If a devisor's heir be ousted by the devisee, by entry on the lands, he may not afterwards have this writ, but is to have his remedy by the ordinary course of the common law. (Co. Litt. 111.) If the claimant's title accrues within 20 years, the most eligible method of proceeding, is now by *ejectment*; which see.

**EXHÆREDATIO**. See EXHEREDATION.

**EXHALATION**, a fume or steam exhaling or issuing from a body, and diffusing itself in the atmosphere.

The terms exhalation and vapour are ordinarily used indifferently, but the more accurate writers distinguish them; appropriating the term vapour to the moist fumes raised from water and other liquid bodies; and exhalation to the dry ones emitted from solid bodies, as earth, fire, minerals, sulphurs, salts, &c. In this sense, exhalations are dry subtile corpuscles, or effluvia, loosened from hard terrestrial bodies, either by the heat of the sun, or the agitation of the air, or some other cause, and emitted upwards to a certain height of the atmosphere, where, mixing with the vapours, they help to constitute clouds, and return back again into dews, mists, rains, &c.

Sir Isaac Newton takes true and permanent air to be formed from the exhalations raised from the hardest and most compact bodies. See AIR, DAMP, EVAPORATION, and VAPOUR.

**EXHAUSTED RECEIVER**, a glass, or other vessel, applied on the plate of an air-pump, and having the air extracted out of it by the working of the engine. (See AIR-pump.) Things placed in an exhausted receiver, are said to be *in vacuo*. See VACUUM.

**EXHAUSTIONS**, in *Mathematics*. Method of exhaustions is a way of proving the equality of two magnitudes, by a *reductio ad absurdum*; shewing, that if one be supposed either greater or less than the other, there will arise a contradiction. The method of exhaustions was of frequent use among the ancient mathematicians, as Euclid, Archimedes, &c. It is founded on what Euclid says in his tenth book, *viz.* that those quantities whose difference is less than any assignable quantity, are equal; for if they were unequal, be the difference ever so small, yet it may be so multiplied, as to become greater than either of them; if not so, then it is really nothing.

This he assumes in the proof of prop. 1. book x. which imports, that if, from the greater of two quantities you take

more than its half, and from the remainder more than its half, and so continually, there will, at length, remain a quantity less than either of those proposed.

On this foundation it is demonstrated, that if a regular polygon of infinite sides be inscribed in or circumscribed about a circle, the space, which is the difference between the circle and the polygon, will by degrees be quite exhausted and the circle become equal to the polygon.

**EXHEBENUM**, in *Natural History*, the name of a white and smooth stone, used by the ancient artificers in polishing gold. It seems to be the same with the lapis Samius, a small smooth stone which they often found in the Samian earth.

**EXHEREDATION**, **EXHÆREDATIO**, in the *Civil Law*, with us ordinarily called disinheriting, is the father's excluding his son from inheriting his estate.

There are fourteen causes of exheredation expressed in Justinian's Novel; without some one of which causes, he decrees the exheredation null, and the testament inofficious, as the civilians call it.

Indeed, by the ancient Roman law, the father might pronounce exheredation without any cause; but the rigour of this law was restrained and moderated by Justinian.

**EXHIBIT**, in *Law*. When a deed, acquittance, or other writing is, in a chancery suit, exhibited, to be proved by witness, and the examiner writes on the back, that it was shewed to the witness at the time of his examination; this is called an exhibit.

**EXHIBITION**, a producing or shewing of titles, authorities, and other proofs of a matter in contest.

Anciently, they used the phrase, exhibition of a tragedy, comedy, or the like; but now we say representation in lieu thereof.

**EXHIBITION**, *Exhibitio*, in our *Old Writers*, is used for an allowance of meat and drink, such as was customary among the religious appropriators of churches, who usually made it to the depending vicar. The benefactions settled for the maintaining of scholars in the universities, not depending on the foundation, are also called exhibitions.

**EXHORTATION**, **HORTATIO**, in *Rhetoric*, differs only from *suasion*, in that the latter principally endeavours to convince the understanding, and the former to work on the affections.

**EXHUMATION**, of *ex*, out of, and *humus*, ground, the act of digging up a body interred in holy ground, by the authority of the judge.

In France, the exhumation of a dead body is ordered, upon proof that he was killed in a duel. By the French laws, a parson has a right to demand the exhumation of the body of one of his parishioners, when interred out of the parish without his consent.

**EXIDEUIL**, in *Geography*, a town of France, in the department of Dordogne, and chief place of a canton, in the district of Perigueux; 18 miles N. E. of Perigueux. The place contains 870, and the canton 8378 inhabitants, in 15 communes, and on a territorial extent of 190 kilometres.

**EXIGENCE**, or **EXIGENCY**, that which a thing requires, or which is expedient and suitable thereto.

**EXIGENT**, or **EXIGI FACIAS**, in *Law*, a writ which lies where the defendant, in a personal action, cannot be found, nor any thing of his within the county, whereby to be attached, or distrained. It is directed to the sheriff, ordering him to proclaim and call the party five county-court days successively, and charge him to appear, under pain of outlawry.

The same writ also lies in an indictment of felony, where the party indicted cannot be found.

It is called an exigent, because it exigit, *i. e.* exacts, or requires the party to appear, or, by forthcoming, to answer the law. If he appear not at the last day's proclamation, he is said to be *quingies*, or *quinto exactus*, and then is outlawed. See OUTLAWRY.

EXIGENTERS, four officers of the court of common pleas, who make all exigents and proclamations, in all actions where the process of outlawry lies.

Anciently, the making writs of *superseas* upon such exigents as passed in their offices, did likewise belong to them; but this branch of business was taken from them under king James I. and committed to a particular officer in the court of common pleas, created by patent. See SUPERSEDEAS.

EXILE, BANISHMENT. See BANISHMENT.

Among the Romans, the word exile, *exilium*, properly signified an interdiction or exclusion from water and fire; the necessary consequence of which was, that the interdicted person must betake himself into some other country, since there was no living without fire and water. Thus Cicero ad Herenn. observes, that the form of the sentence did not express exile, but only *aque & ignis interdictio*. See INTERDICTION.

The same author remarks, that exile was not properly a punishment, but a voluntary flying, or avoiding the punishment decreed: "Exilium non esse supplicium, sed perfugium, portusque supplicii." Pro Cæcina.

He adds, that there was no crime among the Romans, as among other nations, punished with exile; but exile was a recourse people flew voluntarily to, in order to avoid chains, ignominy, starving, &c.

The Athenians frequently sent their generals, and great men into exile, out of envy of their merits, or distrust of their too great authority.

EXILE is sometimes also used for the relegating a person into a place, whence he is obliged not to stir without leave.

The word is derived from the Latin *exilium*, or from *exul*, a banished person; and that, probably, from *extra solum*, out of his native soil.

Figuratively, we use the phrase, *honourable exile*, for an office, or employment, which obliges a man to reside in some remote or disagreeable place.

Under the reign of Tiberius, remote employments were a kind of mysterious exiles. A bishopric, or even a lord-lieutenancy, in Ireland, has been sometimes deemed a kind of exile. A residence, or embassy, in some barbarous country, is also a sort of exile. Accordingly, it is said, that the king cannot even constitute a man deputy, or lord-lieutenant of Ireland, nor make one a foreign ambassador against his will, since these in reality might be no more than honourable exiles. 2 Inst. 46.

EXILES, in *Geography*, a town of France, in the department of the Po, on the river Doria; 5 miles W. S. W. of Susa. This town was fortified, and guarded one of the passes into Piedmont; but by the treaty of peace between the French republic and the king of Sardinia, in 1796, the fortifications were to be razed.

EXILIUM, in *Law*, signifies a spoiling; and, by the statute of Marlbridge, it seems to extend to the injury done to tenants, by altering their tenure, ejecting them, &c. And this is the sense that Fleta determines; who distinguishes between *vastum*, destruction, and *exilium*. For he tells us, that *vastum* and *destructio* are almost the same, and are properly applied to houses, gardens, or woods; but

*exilium* is when servants are enfranchised, and afterwards unlawfully turned out of their tenements. Flet. lib. i. cap. 11. Stat. Marl. cap. 25.

EXIMA, in *Geography*, a tribe or kabyle in the province of Susa, in the southern division of Morocco; amounting to about 11,000 persons.

EXIMENO, ANTONIO, in *Biography*, a Spanish Ex-Jesuit, who had resided at Rome many years, and published in that city, in 4to. 1744, a work, intitled "Dell' Origine e della Regole della Musica," in which, too confident of his own powers, he imagined himself capable, with four years study only, intuitively to frame a better system of counterpoint than that upon which so many great musicians had been formed. Possessed of eloquence, fire, and a lively imagination, his book has been called in Italy, "a whimsical romance upon the art of music, in which is discovered a rage for pulling down, without the power of rebuilding." The author has certainly, with shrewdness and accuracy, started several difficulties, and pointed out imperfections in the theory and practice of music, as well as in the particular systems of Tartini and Rameau; but his own resources and experience are totally insufficient to the task of correcting the errors of the old system, or forming a new one that is more perfect. He has more eloquence of language than science in music. His reasoning is ingenious and specious, even when his data are false; but his examples of composition are below contempt; and yet, they are courageously given as models for students, superior to those of the old great masters of harmony.

When Sig. Eximeno calls fugues and canons Gothic compositions, he does not disgrace their structure any more than he would our cathedrals, by calling them Gothic buildings. Let fugues be banished from the theatres and private concerts, if he pleases, and let them remain in the church as a distinct species of composition, where they were first generated, and where they can never become vulgar or obsolete. The style being naturally grave, requires musical learning, and will, by the solemnity of the words and place of performance, continue to be revered and respected. It is allowed that variety is more wanted in music than in any other art, and by totally excommunicating canons and fugues from the church, the art will lose one capital source of variety, as well as ingenuity; and intelligent hearers will be deprived of a solemn style of music, to be heard no where else.

EXINANITION, the same as evacuation.

EXISTENCE, that whereby a thing has an actual essence, or is said to be, *esse*.

The notion of existence is applicable not only to a created but an uncreated substance: but it must be added, that the existence of created substances, and especially corporeal ones, implies a respect to place, time, and even an efficient cause; whence the schoolmen generally define it, that whereby a thing is formally and extrinsically without [*extra*] its causes, and that here, and now.

Existence and essence come very near the nature of each other; in effect, they only differ in that we have different manners of conceiving the same thing.

For, 1. Essence is usually explained either by the first, noblest, and radical attribute of the thing, *e. gr.* that of body, by extension; that of mind by thinking, &c. or by specifying all the intrinsic attributes; and existence, either by specifying all place and all time, as in that of God; or by specifying some definite place, and time, together with the cause, as in the creatures.

2. The foundation and occasion of this distinction is

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this: that essence belongs to the question, *What is it?* *Quid est?* but existence to the question, *Is it? An est?*

3. Existence, necessarily pre-supposes essence, and cannot be conceived without it; but essence may be conceived without existence; in that essence belongs equally to things that are in *potentia*, and in *actu*; but existence only to those in *actu*. Note, however, that this does not obtain in God, about whose nature and essence the mind cannot think without conceiving his existence.

We have divers ways of arriving at the knowledge of the existence of things. Our own existence we know by intuition; the existence of a God, by demonstration; and that of other things, by sensation.

As for our own existence, we perceive it so plainly, that it neither needs, nor is it capable of any proof. In every act of sensation, reasoning, or thinking, we are conscious to ourselves of our own being, and in this matter come not short of the highest degree of certainty.

As to our knowledge of the existence of a God, though he has given us no innate ideas of himself, yet, having furnished us with faculties of sense, perception, and reason, we can never want a clear proof thereof. See God.

The knowledge of the existence of other things, *i. e.* of external objects, bodies, a world, &c. we only have by sensation; for there being no necessary connection of real existence with any idea a man hath in his memory, nor of any other existence but that of God, with the existence of any particular man; no particular man can know the existence of any other being, but only when, by actually operating upon him, it makes itself be perceived by him. The having the idea of any thing in our mind, no more proves the existence of that thing than the picture of a man evidences his being in the world, or the visions of a dream make a true story. It is, therefore, the actual receiving of ideas from without that gives us notice of the existence of other things, and makes us know that something doth exist at that time without us, which causes that idea in us, though we neither know nor consider how it doth it.

This notice which we have by our senses, of the existence of things without us, though it be not altogether so certain as intuition and demonstration, yet deserves the name of knowledge, if we persuade ourselves that our faculties act and inform us right concerning the existence of those objects that affect them.

Now, besides the assurance of our senses themselves, that they do not err in the information they give us of the existence of things without us, we have other concurrent reasons, as, 1. It is plain those perceptions are produced in us by exterior causes affecting our senses; because those that want the organs of any sense never have the ideas belonging to that sense produced in their minds. 2. Because we find we cannot avoid having those ideas, produced in our minds. When our eyes are shut, we can at pleasure recal to our mind the ideas of light or the sun, which former sensations had lodged in our memories; but if we turn our eyes towards the sun, we cannot avoid the idea which the light or the sun then produces in us, which shews a manifest difference between those ideas laid up in the memory, and such as force themselves upon us, and we cannot avoid having; besides, there is no one who doth not perceive the difference in himself between actually looking upon the sun, and contemplating the idea he has of it in his memory; and therefore he hath certain knowledge, that they are not both memory or fancy. 3. Add to this, that many ideas are produced in us with pain, which we afterwards remember without the

least offence; thus, the pain of heat or cold, when the idea of it is received in our mind, gives us no disturbance, which, when felt, was very troublesome; and we remember the pain of hunger, thirst, head ach, &c. without any pain at all, which would either never disturb us, or else constantly do it, as often as we thought of it, were there nothing more but ideas floating in our minds, and appearances entertaining our fancies, without the real existence of things affecting us from abroad. 4. Our senses, in many cases, bear witness to the truth of each other's report concerning the existence of sensible things without us: he that doubts, when he sees a fire, whether it be real, may feel it too if he pleases; and, by the exquisite pain, may be convinced, that it is not a bare idea or phantom. Such is Mr. Locke's demonstration of the existence of external bodies.

The ingenious Dr. Berkeley has a different system: external bodies, he contends, have no existence, but in a mind perceiving them; that is, they only exist, *quatenus*, they are perceived; and of this he has given us what he and several others account a demonstration.

In reality, "that neither our thoughts, passions, nor ideas formed by the imagination, exist without the mind, he observes, is allowed; and that the various sensations impressed on the mind, whatever objects they compose, cannot exist otherwise than in a mind perceiving them, is not less evident. This appears from the meaning of the term exist, when applied to sensible things. Thus, the table I write on, exists, *i. e.* I see and feel it; and were I out of my study, I should say it existed; *i. e.* that were I in my study I should see and feel it as before. There was an odour; *i. e.* I smelt it, &c. but the existence of unthinking beings, without any relation to their being perceived, is unintelligible, their *esse* is *percipi*." The notion of bodies, he endeavours to shew, is founded on the doctrine of abstract ideas: "What are light and colours, heat and cold, extension and figure; in a word, the things we see and feel, but so many sensations, notions, ideas, or impressions on the sense? And is it possible to separate, even in thought, any of these from perception? The several bodies, then, that compose the frame of the world, have not any subsistence without a mind: their *esse* is to be perceived or known; and as long as they are not perceived by me, nor any other thinking being, they have no shadow of existence at all. The things we perceive are colour, figure, motion, &c. that is, the idea of those things; but has an idea any existence out of the mind? To have an idea is the same thing as to perceive; that, therefore, wherein colour, figure, &c. exist, must perceive them. It is evident, therefore, there can be no unthinking substance or substratum of those ideas: but you may argue, if the ideas themselves do not exist without the mind, there may be things like them, whereof they are copies or resemblances, which exist without the mind; it is answered, an idea can be like nothing but an idea; a colour or figure can be like nothing else but another figure or colour. It may be farther asked, whether those supposed originals, or external things, whereof our ideas are the pictures, be themselves perceivable or not? If they be, they are ideas; if they be not, I appeal to any one, whether it be sense to say, a colour is like somewhat which is invisible; hard or soft, like somewhat intangible, &c. Some distinguish between primary and secondary qualities; the former, *viz.* extension, solidity, figure, motion, rest, and number, they maintain have a real existence out of the mind; as for the latter, under which come all other sensible qualities, as colours, sounds, tastes, &c. they allow the ideas we have of them are not resemblances of any things existing

## EXISTENCE.

existing without the mind, or unperceived, but depend on the size, texture, motion, &c. of the minute particles of matter. Now, it is certain, that those primary qualities are inseparably united with the other secondary ones, and cannot even in thought be abstracted from them, and therefore must only exist in the mind. Can any man conceive the extension and motion of a body without its other sensible qualities? For my part, I find it impossible to frame an idea of a body extended and moving, without giving it some colour, &c. In effect, extension, figure, and motion, abstracted from all other qualities, are inconceivable; where the others, therefore, are, there these too must be, *i. e.* in the mind, and no where else. Again, great and small, swift and slow, are allowed to exist no where without the mind, being merely relative and changing, as the frame or position of the organ changes: the extension, therefore, that exists without the mind, is neither great nor small, the motion neither swift nor slow; *i. e.* they are nothing. That number is a creature of the mind, is plain (even though the other qualities were allowed to exist) from this; that the same thing bears a different denomination of number, as the mind views it with different aspects; thus, the same extension is 1, or 3, or 36, as the mind considers it, with reference to a yard, a foot, or an inch. Nay, many of the modern geometricians hold, that a finite line may be divided into an infinite number of parts, and each of these infinitesimals, into an infinity of others; and so on, *in infinitum*; so that the same thing is either unity or infinity, either no number or all number. In effect, after the same manner as the modern philosophers prove colours, tastes, &c. to have no existence in matter, or without the mind; the same thing may be proved of all sensible qualities whatsoever: thus, they say, heat and cold are only the affections of the mind, not at all patterns of real beings existing in corporeal substances; because the same body which seems cold to one hand, seems warm to another. Now, why may we not as well argue, that figure and extension are not patterns or resemblances of qualities existing in matter; because to the same eye, at different stations, or to eyes of different structure, at the same station, they appear various? Again, sweetness, it is proved, does not exist in the thing sapid, because the thing remaining unaltered, the sweetness is changed to bitterness, as in a fever, or by an otherwise vitiated palate. Is it not as reasonable to say, that motion does not exist out of the mind? since, if the succession of ideas in the mind become swifter, the motion, it is acknowledged, will appear slower, without any external alteration. Again, were it possible for solid figured bodies to exist out of the mind, yet it were impossible for us ever to know it: our senses, indeed, give us sensation of ideas, but do not tell us that any things exist without the mind, or unperceived, like those which are perceived: this the materialists allow. No other way therefore remains, but that we know them by reason's inferring their existence from what is immediately perceived by sense. But how should reason do this, when it is confessed, there is not any necessary connection between our sensations and these bodies? It is evident, from the phenomena of dreams, phrensies, &c. that we may be affected with the ideas we have now, though there were no bodies existing without them; nor does the supposition of external bodies at all forward us, in conceiving how our ideas should come to be produced. The materialists own themselves unable to conceive in what manner body can act on spirit, or how it should imprint any idea on the mind. To suppose, therefore, bodies existing without the mind; is little else than to suppose God has created innumerable beings entirely useless, and serving to no purpose at all. On the whole it appears, that the existence of bo-

dies out of a mind perceiving them, is not only impossible, and a contradiction in terms; but, were it possible, nay real, it were impossible we should ever know it. And again, that supposing that there are no such things, yet we should have the very same reason to suppose there were that we now have. Suppose, *e. gr.* an intelligence affected with the same train of sensations, impressed in the same order, and with the same vividness, would it not have all the reason to believe the existence of bodies represented by his ideas that we have? All our ideas and sensations are visibly inactive; nay, the very being of an idea implies passiveness and inertness; so that it is impossible for an idea to do any thing, or, in strictness, be the cause of any thing; it cannot, therefore, be the resemblance or pattern of any active being, unless opposites can be said to resemble one another. Now, we find a continual succession of ideas of the mind; but these, it has been proved, do not depend on any external body as their cause; it remains, therefore, that their cause is an incorporeal active substance or spirit: for that I am not the cause of my own ideas, is plain from this, that when I open my eyes in broad day-light, I cannot help seeing various objects. Now, the fixed rules or methods wherein the mind we depend on excites in us the ideas of sense, are called *laws of nature*; these we learn by experience, which teaches us, that such and such ideas are attended with such and such other ideas in the ordinary course of things. Ideas are not any how, and at random, produced; there is a certain order and connection established among them like that of cause and effect; and there are several combinations of them made in a very regular artful manner, which we call *bodies*; and the system of those, *the world*. In strictness, however, the connection of ideas does not imply the relation of cause and effect, but only of a mark or sign of the thing signified: the fire I see is not the cause of the pain I feel, but the mark that forewarns me of it; the noise I hear is not the effect of this or that motion or collision of natural bodies, but the sign thereof. The Cartesians own somewhat like this: the action of bodies on our organs, say they, is not the efficient cause of our ideas and perceptions, but only the occasional cause, which determines God to act on the mind, according to the laws of the union of the soul and body." (See CAUSE.) Dr. Berkeley, indeed, taking away bodies, takes away what these philosophers account the occasions of their ideas: "by an occasion, he says, must either be meant the agent that produces an effect, or something observed to accompany or go before it in the ordinary course of things; but matter is allowed to be passive and inert, and cannot therefore be an agent or efficient cause; and this matter primitively, and in itself, is allowed imperceivable, and devoid of all particular sensible qualities; *i. e.* it has not this or that particular colour, this or that particular figure, &c. but has colour in the general, figure in the abstract, &c. but an abstract is no object of sense; matter, therefore, cannot be the occasion of our ideas in the latter sense." See BERKELEY. Princip. of Human Knowl. See ABSTRACTION.

How far the great argument of the maintainers of a material world from the impossibility of God's deceiving us, and from the evidence that he does so, if there be no such thing, will go against this reasoning, we leave to the reader. See Stanl. Hist. Philosoph. part xii. p. 816. where the objections of the ancient Pyrrhonist to the existence of bodies are recited.

As to the existence of spirits, Mr. Locke allows, that our having ideas of them does not make us know that any such things do exist without us; or that there are any finite spirits, or any other spiritual beings, but God. We have ground

ground from revelation, and several other reasons, to believe with assurance, that there are such creatures; but our senses, being not able to discover them, we want the means of knowing their particular existence; for we can no more know that there are infinite spirits really existing by the idea we have of such beings, than by the ideas any one has of fairies or centaurs, he can come to know that things answering to those ideas do really exist.

EXIT, properly expresses the departure of a player from off the stage, when he has acted his part.

The word is also used in a figurative sense, to express an kind of departure, even death.

EXITERIA, Ἐξίτηριαι, in *Antiquity*, oblations or prayers to any of the gods for a prosperous expedition or journey. There were also feasts under this denomination, which were celebrated by the Greeks, with sacrifices and prayers, when their generals undertook expeditions against any enemy.

EXITURA, from *exeo*, to come from, in *Surgery*, an abscess which discharges matter.

EXITUS, ISSUES, in *Law*, the yearly rents or profits of lands or tenements. See *ISSUE*, &c.

EXLEGALITUS, the same with an outlawed person. See *OUTLAW*.

EXLUNZA, in *Geography*, a town of Spain, in the province of Leon; 5 miles S. E. of Leon.

EX MERO MOTU, in *Law*, formal words used in the king's charters and letters patent, signifying that he does what is contained therein of his own will and motion, without petition or suggestion of any other.

The effect of these words is to bar all exceptions that might be taken to the instrument, by alleging that the prince in passing such charter was abused by false suggestions.

EXMES, in *Geography*, a town of France, in the department of the Orne, and chief place of a canton in the district of Argentan; 9 miles E. of Argentan. The place contains 618, and the canton 7358 inhabitants, in 31 communes, and on a territorial extent of 147½ kilometres.

EXMOUTH, though a watering place of considerable size and repute, is only a hamlet belonging to the parish of Littleham, in the county of Devon, England. As its name imports, it stands near the mouth of the river Exe. The buildings in general are low, but here are some good houses inhabited by genteel families. The vicinity is highly picturesque: from an eminence, called Chapel-hill, a line of coast presents itself, which extends from Exeter to Berry-head, a distance of about twenty miles. This line is broken by several hills, behind which spring up some bold towering head-lands.

The plantations of Mamhead and Powderham-castle heighten the beauty of the prospect; which is additionally embellished by the noble buildings connected with those estates. Holinshed mentions a castle erected here to defend the entrance of the haven; and some slight vestiges of embrasures are still apparent. Exmouth is situated 168 miles W. from London; and contains, including the parish of Littleham, 432 houses, and 1909 inhabitants, of whom 570 are returned as employed in trade or manufacture. Polwhele's *Devonshire*, vol. ii.

EXOACANTHA, in *Botany*, from ἐξ ακανθῶν, to be armed with spines; Mart. Mill. *Dict.* v. 2. Billard. *Pl. Syr. fasc.* 1. 10. Willd. *Sp. Pl.* v. 1. 1378. Class and order, *Pentandria Digynia*. Nat. Ord. *Umbellatae*.

Gen. Ch. *General Umbel* of many spreading rays; the inner ones gradually shorter; the innermost extremely short; *partial* of many rays. *General involucre* mostly of 12 channelled leaves, with spinous points; *partial* halved, its intermediate leaf very long, exactly like those of the general *involucre*. *Perianth* scarcely perceptible. *Cor.* uniform,

of five equal, inflexed, heart-shaped petals. *Stam.* Filaments five, longer than the corolla; anthers roundish. *Pistil.* Germen inferior, ovate; styles two, short, straight; stigmas simple. *Fruit* somewhat ovate, striated, separable into two parts. *Seeds* two, ovate, convex and striated on the outside, flat on the inner.

1. *E. heterophylla*. Billard. *Syr. fasc.* 1. t. 2. Gathered by M. La Billardiere near Nazareth. *Root* biennial, tap-shaped. *Stem* two feet, or more in height, slightly zig-zag, branched, round, striated, leafy, smooth. *Leaves* pinnate, smooth; leaflets one or two pair with an odd one; those of the radical leaves ovate, sharply serrated, often cut; those of the stem-leaves lanceolate, acute, narrow, entire, the odd ones very long. *Umbels* terminal, solitary, of about 40 rays; the partial ones of about as many, which are equal and crowded. The *involucral* leaves are very long, prominent, curved downwards, each ending in a sharp spine. *Petals* white. *Anthers* yellowish. This plant is a-kin to the *Echinophora*, (see that article,) but differs generically in the want of a perianth, and in having all the flowers perfect and regular, with naked fruit, not imbedded in the involucre.

EXOCARPUS, from ἐξ, out of, and καρπος, a fruit, because the seed stands naked at the top of a fleshy basis or receptacle resembling a pulpy fruit. Billard. *Voy. Engl. ed.* v. 1. 167. t. 14. Class and order, *Polygamia Monoccia*, or rather, perhaps, *Pentandria Monogynia*. Nat. Ord. *Terebinthaceae*, Juss.

Gen. Ch. *Cal.* Perianth inferior, in five deep roundish, equal segments. *Cor.* none. *Stam.* Filaments five, inserted into the calyx between its segments: anthers small, roundish. *Pistil.* Germen superior, globular; style, short, solitary; stigma peltate, orbicular. *Peric.* none. *Seed* a roundish nut, of one cell, standing on the top of an elliptical, hollow, fleshy receptacle, about thrice its own size. Some flowers have an abortive germen, others have no stamens, all on the same plant.

Ess. Ch. Calyx inferior, in five deep segments. Corolla none. Stamens five. Pistil one. Stigma peltate. Nut of one cell, standing on a hollow fleshy receptacle.

*E. cupressiformis*, the only known species, is an evergreen tree, found in New Holland by M. La Billardiere, as well as by Dr. White. It bears innumerable, compound, pendulous, angular, leafless branches, at whose extremities are situated the minute greenish flowers, produced in the month of May. The fruit is red, not unlike that of the yew in size, form, and colour, but the seed is perfectly exposed to view. This plant has been raised from seed in England, but whether it still remains in the gardens we know not. Its singularity entitles it to notice, and, we believe, it is by no means very tender, if not hardy enough to bear our winters in the open air.

EXOCATACÆLUS, in *Antiquity*, a general denomination, under which were included several grand officers of the church at Constantinople; as, the grand œconomus, grand sacellarius, grand master of the chapel, grand scevophylax, or keeper of the vessels, grand chartophylax, the master of the little chapel, and the protœdicus, or first advocate of the church.

There are many opinions with respect to the etymology of this term. F. Goar apprehends, that all the inferior priests were called Κατακαίλοι, *catacali* q. d. people of a low condition, and that their superiors were called exocatacæli, q. d. people out of the number of catacæli, or above them. Upon the whole, however, he adheres to the sentiment of G. Corelius, who says, that the patriarchal palace, and the apartments of the syncellus, and of the monks in the patriarch's

patriarch's service, were in a very low part of the city which, with regard to the rest, seemed a valley or pit; and that the officers above mentioned had their several houses or palaces έξω, out of the valley; whence the name exocatacæli. M. Du-Cange derives the appellation from their being above the level or rank of the other clerks, and seated at church, &c. in more honourable places erected for that purpose on either side of the patriarch's throne.

The exocatacæli were of great authority: in public assemblies they had the precedence of bishops; and in the patriarchate of Constantinople did the office of deacons, as the cardinals originally did in the church of Rome. Accordingly, in the letter of John IX. to the emperor Basilius Leo, they are called cardinales.

At first they were priests; but some patriarchs of Constantinople, whom Codin does not mention, would have them for the future to be no more than deacons. The reason was, that being priests, each of them had their several churches, wherein they were to officiate on all the grand festival days; so that it unhappily fell out, the patriarch, on the most solemn days, was deserted by all his chief ministers.

EXOC'HAS, or ΕΧΌCΗΕ, from έξω, *without*, and έχω, *to have*, in *Surgery*, a kind of excrescence on the outside of the anus.

EXOCIONITÆ, EXOCIONITES, in *Church Antiquity*. The Arians were first called Exocionites, because, when expelled the city by Theodosius the Great, they retired into a place called Exocionium, and there held their assemblies. Justinian gave the orthodox all the churches of the heretics, excepting that of the Exocionites.

The word is derived from Εξοκίονιον, or Εξοκίονιον, the name of the place above mentioned. Codin, in his *Origines*, says, that the Exocionium was a place encompassed with a wall, built and adorned by Conitantine; and that without the circumference of the wall there was a column, with a statue of that emperor, whence the place took its name, *viz.* from έξω, *without*, and κίον, *column*.

EXOCÆTUS, in *Ichthyology*, a genus of the abdominal kind of fishes; the head is scaly; mouth without teeth; jaws connected at each side; in the gill-membrane ten rays; body whitish; abdomen angulated; pectoral fins large, and formed for flying; anterior part of the rays carinated. These are the flying fishes of English authors.

#### Species.

VOLITANS. Abdomen carinated each side. Linn. *Amœn. Acad.* *Exocætus*, Gronov. *Winged flying fish*, *Donov. Brit. Fishes.*

This is an inhabitant of the American and Red seas, and also those of the warmer parts of Europe: in one or more instances it has been known to appear as far north as Britain. The vastly disproportionate magnitude of the pectoral fins in this genus of fishes affords them extraordinary advantage in effecting their escape when closely pursued by their voracious enemies in the water; but this facility of escape exposes them oftentimes to the attacks of other adversaries, and they not unfrequently elude the pursuit of the bonito, or the porpoise, in their native element, to become the prey of gulls, corvorants, and other aquatic birds that hover over the water to seize on them in their aerial flight. They remain only for a short time suspended in the air before they again dive into the water, and after a pause of a few moments emerge again at some distance. They often quit the water in shoals, and sometimes alight on board ships in great numbers. The flesh is occasionally eaten.

The colour is silvery, with the back rather blueish; the

pectoral fins blueish, edged with yellow; ventral fins and extremity of the tail sometimes reddish.

EXILIENS. Ventral fin reaching to the tail. Gmel. Bloch. *Swallow fish*.

A native of the Mediterranean and Red seas. The colour is silvery, blue on the back, with the fins yellowish at the base, with the extremity blueish. The flesh is in esteem.

MESOGASTER. Ventral fins in the middle of the abdomen. Bloch. *Atlantic flying fish*.

Native of the Atlantic seas, and was observed by Plumier about the coasts of the Antilles. The fish is bright silvery, with the back and fins blueish. The species is sufficiently distinguished by the situation of the ventral fins.

COMMERSONII. Dorsal fin marked with a dark blue spot.

CEPEDE. *Commersonian flying fish*. Shaw *Gen. Zool.*

Described by Commerfon as resembling the first species, except in having a dark blue spot on that part of the dorsal fin nearest the tail, and the ventral fins placed beyond the middle of the abdomen, their tips reaching to about the middle of the anal fin.

The last mentioned species, we are inclined to believe, may not differ specifically from the fish described by Bloch under the name of mesogaster: the evolans and volitans of Linnæus, according to some writers, constitute but one species; and we should also speak with diffidence of the fish denominated exocætus non volitans by Forkal; is it a variety of volitans β; as Gmelin considers, or rather an error arising from some accidental circumstance?

EXOCYSTE, or ΕΧΟCΥCΤΙC, from έξω, *without*, and κύστιC, *the bladder*. Writers define this term of surgery a prolapsus of the lining of the bladder. We are probably to understand by the word, a protrusion of the lining outward, between the fasciculi of the muscular coat of this organ, an occurrence which we know does really sometimes take place. Stones have been found protruded in this manner, carrying along with them a part of the lining of the bladder.

EXODIARY, EXODIARIUS, in the *Ancient Roman Tragedy*, was a droll, or mime, who appeared on the stage when the tragedy was ended, and performed what they called the exodium, or conclusion of the shew, to divert the company.

EXODIUM, Εξοδιον, in the *Ancient Greek Drama*, was one of the four parts or divisions of a tragedy.

The word is formed from the Greek, έξοδοC, *going out*, *digression*, of εξ and οδοC, *way, road*. Festus, lib. v. calls it *exitus*.

The exodium, according to Aristotle, was so much as was rehearsed after the chorus had ceased to sing for the last time; so that exodium with them was far from being what the epilogue is with us, as several people have imagined it was.

The exodium was so much of the piece as included the catastrophe and unravelling of the plot; which catastrophe, &c. in pieces regularly composed, always began after the last singing of the chorus, answering nearly to our fourth and fifth acts. M. Dacier's Comment. on Aristotle's *Poetics*, chap. 12. See *CATASTROPHE* and *CHORUS*.

Among the Romans the exodium was a different thing; it was pretty nearly what farces are with us. After the tragedy was over, came a pantomime on the stage, called the exodiarius, who, by his grimace, jesting, and buffoonery, diverted the people, composed their minds, and wiped away the tears which the tragic spectacle had occasioned to be shed.

Viginere on T. Livy says, the exodium consisted of certain

tain humorous drolling verses, rehearsed by the youth at the end of the fabulæ atellanæ, and answering to our farces. In another place, the same author says, that the exodia were a kind of interludes in the intervals between the acts, partly fable and pleafantry, partly music, &c. to give time both for the fpectators and actors to recover breath. The passage in Livy, whence he takes the notion, is lib. vii. dec. 1. "Ridicula intexta versibus, quæ juvenus inter se more antiquo jactare cœpit, eaque conferta sunt fabulis potissimum atellanis." See also Juvenal.

"Urbicus exodio risum movet Attellanæ  
Gestibus Autonoes."

EXODIUM, in the *Septuagint*, signifies the end or conclusion of a feast.

The Hebrew text calls the day *תַּרְעוּ*, which the Seventy render *Ἐξόδιον*.

In particular, *exodion* is used for the eighth day of the feast of tabernacles, which, it is said, had a special view to the commemoration of the Exodus, or departure out of Egypt, though there is nothing of it expressed in Scripture.

EXODIUM, was also the name of a song sung at the conclusion of a meal or feast.

EXODUS, the second of the five books of Moses.

The word in its original Greek, *Ἐξόδος*, literally imports a going out, or journey; and was applied to this book, because the history of the Israelites' passage out of Egypt is related therein. Besides this, it contains the story of what was transacted in Egypt from the death of Joseph to the delivery of the Jews; as well as what passed in the wilderness, and particularly at mount Sinai, to the building of the tabernacle.

The Hebrews call it *veelle semoth*, q. d. *hæc nomina*, these are the initial words of the book; for the same reason they call Genesis, *beresith*, q. d. *in principio, in the beginning*.

EX OFFICIO, in *Law*, denotes a power which a person has in virtue of his office, to do certain things without being applied to; as a justice of peace may not only grant surety of the peace, at the complaint or request of any person, but he may demand and take it, *ex officio*, at discretion, &c. Dalt. 270.

By a branch of statute, 1 Eliz. the queen, by her letters patent, might authorize any persons exercising ecclesiastical jurisdiction to administer an oath, *ex officio*, whereby supposed offenders were forced to confess, accuse, or clear themselves of any criminal matter, &c. but this branch relating to this oath is repealed by 17 Car. I. cap. 11.

EX OFFICIO *Informations*. See INFORMATION.

EXOLICETUS, in *Natural History*, a name used among the writers of the middle ages to express a small stone which had such a variety of colours that it dazzled, as they say, people's eyes in looking at them. It is said to have been found in Libya. The name is probably only a corruption of the hexacantalithos of Pliny and the older writers; and this seems to have been no other than a name for the opal.

EXOMIS, of *ἐξ, out of*, and *ωμος, shoulder*, in *Antiquity*, a straight narrow garment through which the shoulders appeared. It had something in common with the tunic, and something with the pallium. It was worn by slaves, servants, and the lower classes of people among the Romans.

EXOMOLOGESIS, *Ἐξομολογήσεις*, formed of *Ἐξομολογεῖν, I confess*, a term little used but in speaking of the ancient ceremonies of repentance, whereof the exomologesis, by us called *confession*, was a part.

Some of the ancients, and particularly Tertullian, De

Pœnit. cap. 9. use the word in a greater latitude, as comprehending the whole of repentance.

A public exomologesis was never commanded by the church for secret sins, as may be seen in the capitulars of Charlemagne, and the canons of divers councils.

EXOMPHALIOS, from *ἐξ, out*, and *ομφαλος, the navel*, in *Surgery*, an umbilical hernia, or a disease which consists of a protrusion of some of the abdominal viscera at the navel. The subject will be particularly considered in the article HERNIA.

EXONCHOMA, from *ἐξ, out*, and *ογκος, a tumour*, any large prominent swelling.

EXONEIROISIS, from *ἐξ, out*, and *ονειρος, dream*, a nocturnal pollution or emission of the semen in dreams. This, if it happens but rarely, is usually a sign only of redundant vigour; but if it happens frequently, is a sign of weakness of the seminal vessels, which is most frequently the case.

EXONERATIONE SECTÆ, in *Law*, a writ that lay for the king's ward, to be freed from all suit to the county-court, hundred-court, leet, &c. during the wardship. F. N. B. 158.

EXONYCHOS, of *ἐξ, without*, and *οὐξ, a nail*, in *Botany*, a name given by some of the ancient writers, among whom are Dioscorides and Pliny, to the gromwell or lithospermum. See ÆGONYCHUS.

EXOPHTHALMIA, from *ἐξ, out*, and *ὀφθαλμος, the eye*, in *Surgery*, a disease consisting of a protrusion, or a preternatural projection of the globe of the eye from the orbit, so that the part cannot be duly covered by the eye-lids. The disorder may proceed either from a morbid enlargement of the eye-ball, or what, perhaps, is a still more common cause, some tumour which occupies or diminishes the cavity of the orbit, and consequently displaces the eye.

The affection has several other names besides exophthalmia; as, for instance, bupthalmus, ophthalmoptosis, prolapsum oculi, ecpiemosis, melon, &c.

From the few words already delivered on the subject, it is easy to perceive that exophthalmia may arise from a variety of causes, and must of course require very different modes of treatment in different cases.

One cause of the disorder noticed by writers, is a disease of the fat and cellular substances situated in the orbit, and serving as a support to the eye-ball. In this case the surface of the eye appears more moistened with tears than usual, and the fat and cellular substance becoming thickened and indurated, forces the eye-ball forward out of its socket. As the eye cannot now be properly covered and sheltered by the eye-lids, it inflames, and ulcerates on its surface, and the patient becomes afflicted with very severe and deep-seated pain. This sort of cause is as difficult of removal, when the disease has advanced to a certain extent, as it is difficult of detection at an early period of the case. The famous oculist, Saint Yves, pretends, however, to have sometimes dispersed such thickenings of the cellular substance in the orbit by persevering in the exhibition of calomel and purgative medicines. The same author assures us, that he successfully exhibited the æthiops mineralis to a scrofulous patient for three months, whose eye-ball protruded to the extent of three lines, by reason of a morbid thickening of the cellular substance, and an enlargement of the lachrymal gland.

When the disease does not yield to any remedies, the symptoms may become so urgent as to render the extirpation of the eye indispensably necessary, as is proved by the following case related by Saint Yves. A woman's eye-ball protruded out of its natural situation, in consequence of a morbid thickening of the fat at the bottom of the orbit.

The

## EXOPHTHALMIA.

The disease was attended with insupportable pain, and great restlessness. The symptoms were appeased by the employment of general means, and the progress of the affection was for a time retarded. Three years afterwards, the eye having been left in a projecting condition, Saint Yves was requested to visit the patient. She was now labouring under a violent fever, accompanied with severe head-ach. The globe of the eye was of a leaden colour, and exceedingly prominent, its coats being swollen, and appearing likely to become gangrenous. The medical practitioners who were in the habit of attending the woman were of opinion that the eye ought to be extirpated. The necessity for performing the operation, indeed, seemed to them so urgent, that the proceeding was immediately adopted. The febrile and all untoward symptoms subsided on the fourth or fifth day, and, in about three weeks, the cure was complete.

Exophthalmia may also be occasioned by some tumour of the surrounding parts, either of those within, or of others on the outside of, the orbit. The celebrated French surgeon, M. Louis, met with a man, 40 years of age, in whom a carcinomatous fungus, situated in the antrum, had destroyed the bony plate which constitutes the bottom of the orbit, and pushed the eye-ball almost entirely on the cheek, so as to produce a great deformity of the countenance. The upper jaw bone was carious, both towards the palate and nose, and the patient perished of the afflicting complaints, brought on by the carcinomatous ulceration of all the diseased parts. The exophthalmia was the effect of the prodigious size of the tumour, the growth of which could not be effectually resisted by the bones. The protrusion of the eye, says M. Louis, might have been prevented by attacking the first disease at a proper period, on the side towards the mouth. The growth of the cancerous fungus is represented by this distinguished writer as the effect of a disease of the bone, which latter affection he describes as the consequence of syphilis, which had not been skilfully treated.

Raw makes mention of a child whose left eye was completely protruded from the orbit, and as large as one's two fists. The disease, which had only begun a few months before, proved fatal. On opening the cranium, a fungous swelling was discovered, the base of which was connected with the dura mater above the orbit, without any disease of the cerebrum.

Exophthalmia, however, originates still more frequently from the enlargement of an exostosis, which arises within the orbit, and forces the eye-ball out, in proportion as it increases in magnitude. When the bony swelling is situated near the edge of the orbit, the tumour may be attacked with beneficial effects, without meddling with the eye itself. The truth of what has just now been observed is illustrated by the following case. A woman, 30 years of age, had a fistula lachrymalis, for which she had undergone an operation to no purpose. The bones became enlarged, and, fifteen years afterwards, an exostosis of the os planum and internal angular process of the os frontis had attained the size of an egg. The globe of the eye, being laterally compressed, was forced out of the orbit, and, in some measure, hung over that part of the cheek which was near the lesser angle. M. Brassant applied a caustic to the exostosis; suppuration ensued, and in the course of three or four months an exfoliation of a considerable portion of the bony swelling took place, the eye resumed its natural position, and the cure was completed a short time afterwards.

Exophthalmia is sometimes produced by the formation of a sciatomatous, or schirrous tumour, at the bottom,

or sides of the orbit. Trincavelli, Bonnetus, and Saint-Yves, furnish us with several examples of this sort. Here an operation is requisite; but a great deal of patience and dexterity are essential in its performance. As the recital of facts tends to the elucidation both of precept and practice, we shall offer an abridged account of a case, related by Dr. Hope, in the Philosophical Transactions, where every thing respecting the method of treatment is very perspicuously explained. A young woman, eighteen years of age, was affected, when twelve years old, with a distortion of her left eye, towards the temple. This circumstance arose gradually, in consequence of the growth of a tumour between the eye and the orbit. In a few years, the swelling protruded externally, in the form of a hard tumour, which extended from the greater angle nearly to the lesser one, beneath the lower eyelid, and which reached nearly half an inch over the cheek. This tumour had pushed almost the whole eye-ball out of the orbit, so that the pupil was removed more than three inches from its proper place. The eye was also much more prominent than the other, pushed over the temple, and quite motionless, which circumstances, together with the tumour, presented a frightful appearance. The sight, however, was not lost. Dr Hope, though dissuaded by Monro, undertook the cure of the patient in the year 1744. Having placed her in a convenient posture, and made the integuments tense, he made an incision about an inch long, from the greater to the lesser angle, following the direction of the fibres of the orbicularis palpebrarum muscle. The lips of the wound being separated, he next passed a crooked needle, armed with some silk, through the middle of the tumour, and, regularly as he cut all the adhesions with a bistoury, he drew outward the whole mass of the disease. Scissors were employed for dividing such connections, as were the most deeply situated. The part which was thus cut out appeared to be furnished with a thick membranous substance, exclusively of the body of the tumour, which was of a regular, spherical, smooth form, and about as large as a small pigeon's egg; the interior was of a fleshy structure. In detaching the swelling from its adhesions, several callous indurations were met with, attached to the globe of the eye. The tumour being extirpated, Dr Hope introduced his finger to the bottom of the orbit, where he felt several hardneses and callosities still remaining; he kept his finger there, and having by this means passed in a needle and ligature, he drew them through the base of the callosities. Now having directed an assistant to hold up the ligature, he passed in the point of a pair of scissors, on the end of his finger, and made two or three strokes with them, in the place where he felt the roots of the callous hardneses. Thus he succeeded in cutting away the whole of the indurated parts, so as to leave the bottom of the orbit, as far as he could ascertain, perfectly smooth and free from callosity. All the time that the operation lasted, no hæmorrhage of any consequence took place: only a large quantity of dark-coloured grumous blood was poured out from the varicous vessels. The wound was dressed with some dry lint, which was not removed till the third day. The eyelids and tunica conjunctiva were affected with a slabby kind of swelling, attended with a slight inflammation and pain in the anterior part of the head. The dressings consisted of simple digestive and resolvent applications. The pain in the head, and the tumefaction continued three days, without any formation of matter. Dr. Hope then touched the bottom of the wound with the lapis infernalis, and, a few hours afterwards, a large quantity of black blood was discharged. From this period the pain in the head, and the

## EXOPHTHALMIA.

Swelling subsided; there was also emitted, during the two succeeding days, a bloody sanies, which occurrence induced Dr. Hope to make use of some injections of warm water, mixed with a little spirit of wine, and honey of roses. After the adoption of this plan of treatment, the pus assumed a more favourable appearance. Such soft, fungous excrescences as arose in the course of the cure, were destroyed with the lapis infernalis, and it was not long before the wound was entirely healed. The eye, however, remained unalterably immovable; for the abductor muscles had been so long contracted, while the adductors had been for so considerable a time stretched and tense, that they had completely lost all power of action.

Finding, that by making rather forcible pressure on the eye-ball, the part could be made to return, in a great degree, into the orbit, though it became protruded again as soon as such pressure was discontinued; Dr. Hope conceived, that a bandage which would constantly keep up a graduated compression, might be attended with some benefit, and determine the muscles more speedily to resume their proper tone, by maintaining the eye in its natural situation. Conformably to this idea, this gentleman caused a steel bandage to be constructed, with a concave plate proportioned to the convexity of the globe of the eye. This apparatus made pressure on the side of the eye-ball next the temple, by means of a screw. The machine was put on, after gently pushing back the eye into its natural situation with the hand; and then laying a soft compress between the eye and the plate of copper, Dr. Hope used to make the pressure act on the part by means of the screw, in such a way, that it was impossible for the eye to become displaced outward again, as it usually was before. With the aid of this bandage, which the patient wore constantly, night and day, and which was gradually tightened more and more, the eye regained its natural position in the space of about twenty days, and did not deviate from it again. At the time when the case was published, the eye was capable of motion in every direction, and the patient could see quite as well with it as the other. The wound got completely well in about a month, and only seven weeks elapsed before the cure was, in every respect, perfect.

Respecting the foregoing case, M. Louis observes, that it certainly does honour to the skill and intelligence of the gentleman who undertook the treatment.

Le Dran was equally successful in the treatment of a similar disease, though certainly it was not so considerable as the preceding. The means made use of, were the actual cautery and alternative medicines. The subject was a young lady, aged eighteen, who, from her infancy, had been subject to inflammations about her lips, eyes, and ears. She had had a fistula lachrymalis, and, some time after the usual operation for this complaint, there originated, at the lesser angle of the eye, a fungous excrescence, which protruded from the orbit, and had been successively removed with the knife, and touched with the lapis infernalis; but in vain, as the tumour always made its appearance again. This plan of treatment was not attended with any greater success under the hands of Le Dran, and, consequently, he soon made up his mind to attack the excrescence, by introducing the actual cautery into its centre. For this purpose, he took a long, large, sewing needle, and had it firmly fixed on a handle. The instrument, having been made red-hot in the flame of a wax-candle, was pushed to the depth of about half an inch into the middle of the swelling. By repeating the application of the cautery three or four times, at intervals of a few days, Le Dran succeeded in destroying the tumour as deeply as its root,

the action of the fire having extended beyond the parts actually touched with the heated needle. The consequence was, that the swelling never grew again. To render this cure more certain, Le Dran, for a long while, kept the cauterised part open, and the patient was ordered to take alternative medicines, the chief of which were calomel and aethiops mineralis.

The two foregoing examples prove what surgery can accomplish, when the disease is taken in time. However, when the proper kind of treatment has been deferred too long, the affection of the eye becomes of such a description, as to be irremediable. Nothing now remains to be done except extirpating, not only the tumour, but also the whole of the eye-ball. Even this formidable operation is often impracticable, particularly when the parietes of the orbit are diseased. For the bones, in consequence of the pressure made upon them by the swelling, are rendered carious, and very foul ill-conditioned ulcers are produced. In this state there can be but little hope of a recovery, whatever mode of treatment is adopted.

One species of exophthalmia, which is indeed uncommon, but not the less worthy of being known, is that which is occasioned by an encysted tumour. In the fourth volume of the Medical Observations and Inquiries, there is an instance recorded by Dr. Broclesby. A labouring man of the parish of Haselmere, in Surry, had been for several years afflicted with a pain and an obscurity of sight in one of his eyes. The affection continued, without much attention being paid to it, until, about two or three years afterwards, the man became quite blind on that side. At this period, the globe of the eye was protruded outward in such a manner, that almost the whole of the inner surface of the lower eye-lid was turned out, and hung down over the cheek, so as to form a true ectropium.

Several surgeons who were consulted advised the patient not to expose himself to the risk of an operation, fearful that the disease might be converted into one of a cancerous nature. Notwithstanding this counsel, the man did not cease going about to have the advice of all such persons as seemed likely to afford him any assistance. At length, he applied to Mr. Dale Ingram, who, having carefully examined the disease, thought, that on compressing different places, he felt a decided fluctuation below the globe of the eye. He immediately suspected, that the fluid was contained in a cyst, and, consequently, that the patient might receive relief from an operation. However, the above gentleman would not undertake any thing without consulting Mr. Bromfield.

The latter surgeon, after a careful examination, was not against the probability of success, and he did the operation in the following manner. After having covered the sound eye, by tying a handkerchief round the head, and put the eye-lids of the affected eye as near together as possible, and directed them to be held in this position, Mr. Bromfield made an incision through the lower eye-lid to the conjunctiva, and thus made a sufficient opening for the introduction of his finger behind the globe of the eye. In this way he was enabled to put in a very narrow sharp-pointed knife, for the purpose of puncturing the substance, which was taken to be the cyst. Mr. Bromfield was not deceived in his expectation; for, as soon as the opening was made, nearly a glassful of a thin transparent fluid was discharged. He now waited a little, both in order to give the patient an opportunity of washing out of his mouth some blood, which had got into it, and for the sake of considering what steps could be taken to extirpate the cyst, which had contained the fluid. At last, he determined to proceed as follows: he

passed into the wound a double kind of tenaculum, with which he took hold of the cyst, and then dissected it entirely away. The wound was filled with soft lint, and the dressings were kept on with a suitable bandage.

In less than four and twenty hours there appeared on the same side of the face a considerable degree of swelling, which soon subsided, however, on a dilatation of the first wound being made, lighter dressings being put on, and the bowels opened. In less than a month the man got quite well, and returned to his home with infinite satisfaction. Dr. Broclesby observes, that Mr. Ingram was persuaded, before the operation, that the muscles would draw back the eye-ball into the orbit, and that even some degree of vision might return. The doctor could hardly suppose all this possible; but, having an opportunity of seeing the man, about five months afterwards, he could scarcely recognize him. The eye-lids had recovered their original state, and moved as well as those of the opposite eye. The man also informed Dr. Broclesby, that, for about the last month, he had begun to distinguish with the affected eye light from darkness, and that his power of seeing was becoming greater every day. Dr. Broclesby remarks, that he could not find any case of this kind related by authors, except one very analogous instance, recorded by Saint Yves in his treatise on the diseases of the eyes.

The last kind of exophthalmia which we have to notice, is that which Sauvages has termed *traumatic*. In this sort of case, the eye is so much protruded from the orbit, that surgeons have frequently been induced to remove the displaced part altogether, and this sometimes has been done too inconsiderately for the unfortunate patient. Covillard informs us, in his *Chirurgical Observations*, that he was called to see a man, against whose eye a racket-ball had been struck with such violence, that all the circumference of the globe of the eye was separated from the orbit. A relation of the person who was hurt was standing by with a pair of scissars in his hand, ready to cut the rest of the parts which connected the eye with the head. Covillard entered the room in time, and very fortunately, to resist this proceeding, as a complete cure ensued without having recourse to it. Indeed, such was the success, that the patient's power of seeing suffered no kind of diminution or impairment. A similar instance, though arising from a very different cause, occurred to Mr. Benjamin Bell. The eye was almost knocked out of the orbit by the violence with which a pointed piece of iron had entered betwixt the socket and the eye-ball. The iron had passed through a portion of the orbit, and remained firmly fixed there for about a quarter of an hour. During the whole of this time, the patient suffered insupportable pain. He had completely lost the faculty of seeing, and the eye-ball protruded in such a manner, that there was every reason to fear that the optic nerve was ruptured, and, consequently, great doubt concerning the propriety of replacing the part, or not. However, as a little delay did not seem likely to be dangerous, it was determined to wait a little. On the first removal of the dressings, and after taking away the iron, which could only be done with difficulty, so deeply had it stuck, it was with pleasure and astonishment that the sight was found to return immediately, even before the eye had been replaced. The inflammation which followed was soon appeased by proper remedies, and vision was re-established in its original perfection.

Mr. White makes mention of an analogous example in his book of surgical cases, with this difference, however, that the eye was protruded in a still greater degree.

These two instances confirm the one recorded by Covil-

lard, and weigh against what Maitre Jean has stated, namely, that Covillard's case is not authentic.

In order to conceive the truth of the foregoing observations, we have only to recollect the way in which the eye is retained in, and connected with the orbit. The surface of the boundaries of each orbit (says M. Louis, in defending Covillard's case,) is oblique, and inclines behind more towards the temple than the nose. The eye-ball is fixed on the side towards the nose, and juts out in front beyond the cavity of the orbit. Hence, it is manifest from the slightest examination, that the globe of the eye, in the natural state, is partly situated on the outside of the orbit. When it is also considered that the optic nerve is very loose, in order to be adapted for readily following, without being at all stretched, all the rotatory motions of the eye-ball, produced by the action of the different muscles belonging to this organ, we can then have no difficulty in imagining how the eye may make an immense protrusion outward, in consequence of an inconsiderable swelling, and how it may seem to be quite displaced from its socket, without either the optic nerve or the muscles being torn or lacerated.

**EXORCISM**, Εξορκισμός, prayers or conjurations wherewith to exorcise, *i. e.* to drive out devils or dæmons from persons apprehended to be possessed, or to preserve from danger.

The word is derived from the Greek, εξορκίζω, *adjurare, conjurare, to adjure, or conjure*. In most dictionaries, exorcism and conjuration are used as synonymous; but in reality, conjuration is only a part of the exorcism; and the exorcism the ceremony entire. The conjuration is properly the formula, where the devil is commanded to come forth, &c.

Exorcisms are of great use in the Romish church; their prelates, &c. are frequently exorcising demoniacal persons. The priests make holy water by exorcising common water a certain number of times. In reality, the exorcism is a part in most of their consecrations.

Exorcisms had anciently another and farther purpose; being applied by way of trial or purgation to extort the truth from the accused.

The exorcism, in this sense, was a sort of bread conjured and exorcised for the purpose; and the opinion was, that if the person was criminal he could not swallow the bread.

This, it seems, was a frequent practice in the time of our Edward III. and the bread thus exorcised was said to be cursed.

Linderbroeck gives instances of exorcisms with barley-bread, and others with cheese; and hence, probably, might arise that popular imprecation, "May this bread choak me, if I tell a lye." See **ORDEAL** and **JUDICIUM Dei**.

**EXORCIST**, in the *Romish Church*, a priest, or tonsured clerk, who has received the four lesser orders, one of which is that of exorcist.

The term is likewise applied to a prelate, or to a priest delegated by a prelate, who actually exorcises a person possessed.

It is a dispute among divines whether ever the Greeks had any such order as that of exorcist. Fa. Goar, in his *Notes on the Greek Euchologion*, has made it probable they had, from several concurring passages in St. Dionysius and St. Ignatius Martyr.

The ordination of exorcists is performed in the time of mass, their principal office being to expel devils. The fourth council of Carthage, can. 7. appoints, that in the ordination of exorcists, the bishop, putting the book of ex-

orcisms in their hands, shall say these words: "Receive it, and keep it in remembrance, and have power to lay hands on envergemeni, whether baptised or catechumens; which form still obtains."

M. Fleury mentions certain people among the Jews who travelled round the country, making profession of driving out devils by invocations, which, they pretended, had been taught them by Solomon; these were also called exorcists. See Joseph. Antiq. Jud. lib. viii. cap. Origen. Tract. xxxv. in Matt. 35. 63.

EXORDIUM, in *Oratory*, the preamble or beginning of a discourse or speech, serving to prepare the audience and introduce the matter in hand.

The word is formed from the Latin *ordiri*, to begin, by a metaphor taken from the weavers, who are said, *ordiri telam*, to begin, or *warp* a web, by disposing and ordering the threads in a certain manner for the future work. See *WARP*.

The exordium, on other occasions, is called the *prologue*, *prælude*, and *proem*.

Cicero defines exordium a part of an oration, whereby the minds of the audience are duly prepared for what remains to be said. The exordium is a part of principal importance, and is to be laboured with extraordinary care; whence Tully calls it "difficillima pars orationis."

Cicero and Quintilian mention three ends, to one or other of which it should be subservient; viz. "reddere auditores benevolos, attentos, dociles." The first end, or that of conciliating the good will of the hearers, may be effected by a selection of topics, in causes at the bar, from the particular situation of the speaker himself, or of his client, or from the character and behaviour of his antagonist contrasted with his own; on other occasions, from the nature of the subject, as closely connected with the interest of the hearers; and, in general, from the modesty and good intention with which the speaker enters upon his subject. The second end, or that of exciting and engaging the attention of the hearers, may be accomplished by giving them some hints of the importance, dignity, or novelty of the subject; or some favourable view of the clearness and precision with which it is to be treated, and of the brevity with which it is to be discussed. In order to effect the third end, or to render the hearers docile, or open to persuasion, the speaker must begin with studying to remove any particular prepossessions they may have contracted against the cause, or side of the argument which he espouses.

The ancient critics distinguish two kinds of introduction, which they call "Principium," in which the orator plainly and directly professes his aim in speaking; and "Insinuatio," where, presuming the disposition of the audience to be much against the orator, he must gradually reconcile them to hearing him, before he plainly discovers the point which he has in view. Of this latter sort of introduction we have an admirable specimen in Cicero's second oration against Rullus.

Exordiums are of two kinds; either just and formal, or vehement and abrupt. In the first, the audience is prepared and conducted by due and easy steps; in the second, the orator, as if seized with some sudden passion, breaks out upon his audience at once. Such is that exordium of Isaiah; "Hear, Oh heavens! and give ear, Oh earth!" Or that of Cicero against Catiline; "Quousque tandem abutere patientia nostra, Catilina?" Abrupt exordiums are most suitable on occasions of extraordinary joy, indignation, or the like; though we have instances of panegyrics of the greatest orators, begun abruptly, without any such occasions. Such is that of Gorgias, who began his elege of the

city and people of Elis with *Ἠλίας, ἡ πόλις Ἠλιεύων, Elis, beata civitas*. Abrupt, hasty, exordiums, were more to the taste and manner of the Greeks than of the Latins.

Agreeably to the objects which the orator should have in view in this part of his discourse, as we have already stated them, the requisites in an exordium are, 1. *Propriety*, whereby the exordium appears easy and natural, becomes of a piece with the whole discourse, and matches it as a part does the whole; so that it could not be accommodated to any other, or, perhaps, a contrary occasion. The ancient orators were very defective in this point; their exordiums had frequently nothing in common with the subject.

In order to render introductions natural and easy, Dr. Blair suggests that they should not be planned, till the substance of the discourse has been thoroughly digested in the mind. This mode of forming an introduction is conformable to the rule given by Cicero, though not always to his practice. "Omnibus rebus consideratis," says he, "tum denique id quod primum est dicendum, postremum soleo cogitare, quo utor exordio. Nam si quando id primum invenire volui nullum mihi occurrit, nisi aut exile, aut nugatorium, aut vulgare;" i. e. "when I have planned and digested all the materials of my discourse, it is my custom to think, in the last place, of the introduction with which I am to begin. For if at any time I have endeavoured to invent an introduction first, nothing has ever occurred to me for that purpose, but what was trifling, nugatory, and vulgar."

2. *Modesty*, or an ingenuous bashfulness, which recommends the orator exceedingly to the favour of his audience. This is what Cicero extols so much in L. Crassus, "Fuit enim in L. Crasso pudor quidnam, qui non modo non obesset ejus orationi, sed etiam probitatis commendatione prodesset." The same Tully owns of himself, that at the beginning of his oration every limb trembled, and his whole mind was in a flutter. The vain-glory of that author should be carefully avoided, of whom Horace speaks, and who began his poem "Fortunam Priami cantabo et nobile bellum."

The modesty of the orator should discover itself not only in his expressions at the beginning, but in his whole manner; in his looks, in his gestures, and in the tone of his voice. However, the modesty of an introduction should never betray any thing mean or abject. The orator, whilst he exhibits to his hearers modesty and diffidence, real and not affected, should manifest a becoming sense of dignity, arising from a persuasion of the justice or importance of the subject of which he is to speak. The modesty of an introduction requires that it should not promise too much. "Non fumum ex fulgore, sed ex fumo dare lucem." Horace.

"He does not lavish at a blaze his fire,  
Sudden to glare, and then in smoke expire;  
But rises from a cloud of smoke to light,  
And pours his specious miracles to sight."—Francis.

Although, in general, the orator should not put forth his whole strength in the beginning, but gradually, rise as his discourse advances; yet there are cases in which he may be allowed to set out in a high and bold tone; e. g. when he rises to defend some cause which has been much decried by the public. In subjects too of a declamatory nature, and in sermons, where the subject is striking, a magnificent introduction has sometimes a good effect, if it be properly supported in the sequel. Bossuet, Flechier, and the other celebrated French preachers, very often begin their discourses with laboured and sublime introductions; these raise attention, and throw a lustre on the subject; but every speaker should be on his guard against striking a higher note

at the beginning than he is able to keep up in his progress, and thus disappointing the expectations which he has excited. Among English preachers, attempts of this kind are not always so successful. Variety should be studied in introductions as much as possible. Explanatory introductions from the context are the most simple of any, and frequently the best that can be used; but they should never be long. An historical introduction has generally a happy effect in rousing attention; when one can lay hold upon some noted fact that is connected with the text or discourse, and by a proper illustration of it, open the way to the subject that is to be treated of.

3. *Brevity*. not amplified or swelled with a detail of circumstances, or a long circuit of words; and in this respect it should be accommodated to the length of the discourse; nor should the introduction anticipate any material part of the subject.

4. The *style* of the exordium should be just, easy, and pleasant. Quintilian facetiously compares a faulty exordium to a scarred face, which is presently discerned, and very disagreeable. Thus, Cicero, "Vestibula, aditusque ad causam facias illustres."

Correctness of expression is peculiarly requisite on account of the situation of the hearers, who are then more disposed to criticize than in any other stage of the oration or discourse; because they are as yet unoccupied with the subject or the arguments, and their attention is chiefly, if not wholly, directed to the speaker's style and manner. A correct plainness, an elegant simplicity, is the proper character of an introduction; "ut videamur," says Quintilian, "accuratè non callidè dicere."

5. *Calmness* of manner is peculiarly suitable to the exordium. This is seldom the place for vehemence and passion. Emotions must rise as the discourse advances. The minds of the hearers must be prepared, before the speaker can venture on strong and passionate sentiments. To this rule there are some exceptions, as, for instance, when the subject is such that the mere mention of it naturally awakens some passionate emotion, or when the unexpected presence of some person or object, in a popular assembly, inflames the speaker, and makes him break forth with unusual warmth. Either of these will justify what is called the exordium *ab abrupto*. An instance of this kind we have already referred to in Cicero's first oration against Catiline. However, introductions of this kind should rarely occur. In the introduction the speaker should prepare the way for those warm emotions, which he designs to raise in the subsequent parts of his discourse.

The exordium appears an essential part of an oration; though anciently in the Areopagus, Julius Pollux tells us they spoke without any exordium, and passions, and any peroration or epilogue. The like is said to have been done by Xenophon, who began thus: "Darius et Parisatis duos habuere filios."

EXORMISTOS, in *Ichthyology*, a name given by some of the old writers to that species of the petromyzon which other authors call the lampetra fluviatilis, and we in English the lampern. This is distinguished by Ardedi by the name of the petromyzon, with only one series of small teeth in the verge of the mouth, and some large ones, below. See MUSTELA, LAMPETRA, and PETROMYZON.

EXOS, the name by which Rondeletius distinguishes the acipenser huso. See STURGEON.

EXOSTOSIS, from εξ, *out of*, and οστεον, *a bone*. This term, in *Surgery*, signifies an osseous tumour growing on a bone. Also, a swelling of the bone itself.

Boyer remarks, that a swelling may take place in bones

as well as other parts of the body. The particular kind of tumour which occasionally forms on the surface of the bones, is that to which this writer assigns the appellation of *exostosis*. He notices, however, that this name comprehends different species, which should be considered in a distinct manner. Thus, *osteosarcoma* is one peculiar affection; and there is another species of exostosis, different from all others, and which consists principally in a thickening of the periosteum. Boyer is of opinion, that the disease might be very properly named *periostosis*.

In cases of exostosis, the bony swelling acquires, on some occasions, such a degree of hardness, that no vestiges of a fibrous texture can be discerned, and it absolutely resembles ivory. In some instances, the structure of the tumour is spongy; and in others the swelling is composed of a mass of fleshy and bony matter blended together.

According to Boyer, the bones most frequently affected with exostosis are the broad bones of the head, the lower jaw, sternum, humerus, radius, cubitus, the bones of the carpus, and the femur, and tibia. However, he remarks, that there is bone, which may not become the seat of the disease, and the affection may extend to a small, or a considerable portion of it. It is not uncommon to find the bones of the cranium affected with exostosis over their whole extent; and Boyer instances the ossa parietalia, as sometimes acquiring an inch in thickness, in consequence of the affection.

In the majority of cases, an exostosis rises from the surface of a bone, and appears in the form of a hard round tumour. It sometimes occurs near the extremities of the long bones, and, at other times, near the middle portion. It is remarked, that exostoses, originating from a venereal cause, and commonly called *nodes*, are found, for the most part, on compact bones, and such of these as are not thickly covered with soft parts, as, for instance, the bones of the cranium and face, the internal side of the tibia, &c.

Mr. John Bell has treated of tumours of the bones in the third volume of his *Principles of Surgery*. The following extract will serve to shew some of this gentleman's opinions upon the subject: "Many things conspire (says this author) to give the tumour proceeding from a bone a peculiar aspect; it is always irregular and anomalous, never simple. I have rarely seen a single bony protuberance arising from the head, or shaft, of a single bone. When a bone falls into disease, a large proportion of tendinous and muscular parts of bursæ, and of cellular substance partake of the morbid action. The bone lies in the centre of the limb, connected by its larger head with a joint, and by its periosteum with the tendons, bursæ, and muscles; and all this mass of parts is, sooner or later, affected; and since every deposition from vessels appointed for the secretions of bone is solid, and every increase of such a tumour permanent, it soon attains a great size; it is ponderous and massive from the proportion of bony secretion, and from the various structure of these several parts, it has every irregularity of form and substance.

"When the tumour of a bone has attained a considerable size, much of the original structure is destroyed, and a new irregular mass of gelatinous and bony matter is substituted for it. The bony tumour is firm, bulky, and ponderous, but not solid; feeling it from without, we can conjecture of what substance it is composed within; we are sensible that the tumour is covered by a shell, bony in most parts of its circumference, cartilaginous in some parts, and, throughout the whole, yielding and elastic; we are sensible, also, that within there are irregular points, or spiculae traversing the cavities, or cells, of the hollow tumour; that these are mixed with the cartilaginous substance, and with irregular collections

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of matter, partly purulent, but chiefly gelatinous; we are sensible of such soft cartilaginous and gelatinous parts being successively added, in the progress of its growth to the tumour, which was, at the first, solid and firm; and we find at last, by pain and partial ulcerations, and by the increase of fluctuation and redness at particular points, that ulceration, the last stage of the disease, approaches. Then the limb is effectually ruined, and the patient must submit to amputation, or die of hectic.

“When such tumour is dissected, we find our suspicions of its internal structure confirmed; we see that foul matter flow out, when we open into the centre of the tumour, which we felt but indistinctly through its walls; the parts which appeared the most solid are hollowed out by ulceration, and full of foul and putrid sanies; while the bone has been declining into disease, the cancelli and marrow have been degenerating into a sort of fatty mass, with which much of the cavity of the tumour is filled, and thence such disease has been very generally described under the name of *osteosteoma*. This fatty excretion, occupying the diseased cavity, is the part which, when the tumour bursts into an open ulcer, throws out such prolific fungus, growing apparently from the substance of the bone, and sprouting up, when amputated, in the course of a few hours. The solid bone, whether radius, or thigh-bone, is annihilated, and a mere shell of osseous matter substituted in its place, and that in a manner so peculiar, that it must seem to the unintelligent observer as if the small and solid bone had been expanded into an extensive and flat plate of osseous substance, whereas the process is in truth very simple and very intelligible. The bone dies piecemeal of ulceration, what, in technical language, is termed caries, and is conveyed away by absorption; but the bone being dead, the surrounding membranes, *viz.* the periosteum and tendinous expansions, which once formed a part of its system of circulation, continue still alive and ready to secrete new bone; and thus it happens, that while a carious abscess preserves a large cavity full of foul matter, the surrounding membranes continue secreting bone, which, like a shell, thin and expanded, covers this cavity, and forms the walls of the tumour, of which some part is composed of thin expanded bone, resembling a cranium, some of cartilage, some of thickened membrane; and this shell is formed in proportion as the original fabric of the bone is destroyed.

“Bone is destroyed by this internal ulceration, just as it is by open caries, piecemeal; the process would not be ulceration, if, while one part were perishing, the other were not active and secreting new matter; so vigorous still is the general life of the bone, while the internal parts are thus suffering, that while one side is wasting with ulcer, the other side is often secreting bone irregularly and profusely, and shooting out into fantastic forms among the membranes and surrounding soft parts, whence the centre of the tumour is cavernous and cellular, and the walls often rough with spinous and projecting points. So merely local is the action of arteries in a tumour, whether osseous or soft, that one side, or part, or bump of a tumour, grows visibly and protrudes; the features and external form of the tumour gradually changing, without any sensible cause; and so peculiar is the secretion of each species of vascular structure, according to the original destination of the part, that in one part of the tumour is generated bone, in another gristle, in another gelatinous effusion; while in another part, the vascular action is violent and destructive, and the solid bone, marrow, and surrounding membranes, are all resolved into a foul and fetid suppuration. From the periosteum is secreted bone: from the marrow, this steatomatous and solid fat, with which much of the

tumour is filled; to the tendinous and aponeurotic parts we can distinctly trace the cartilaginous secretion; and the gelatinous effusions, we can perceive, even during life, have their walls thicker, or thinner, according to the degree of inflammation.

“These are the external characters and internal conditions of a tumour occupying any of the bones. Such tumour arises often from a bruise, or fracture; sometimes from a less obvious cause, or from internal disease. The radius, for example, is fractured at the wrist, re-unites and heals; but heals clumsily, the thickening never subsides, the pain never ceases, and, though not great, is greater than what is natural to a fracture. At length, a sensible tumour arises; at first it is firm, but in proportion as it increases in size, it becomes somewhat soft and elastic, the thin plate of bone, of which it is composed, yielding to the distention from within. From time to time the tumour changes its form, still increasing in bulk. On the side of the radius, it is firm and solid; it bends and yields at the parts most distant from it; it is plainly bony at its basis, and as obviously cartilaginous in the extreme part of its circle; it plainly contains matter in those softer parts, where it yields to the impression of the finger. Cartilaginous knobs arise, and sometimes are reddened on the surface; and, at certain points, the fluctuation is of such a kind, as to imply that the effusion is in part of a gelatinous nature. Thus the tumour grows and extends, with various irregularities in form and consistence; it overhangs the dwindled hand, the use of the joint is lost, and the patient, who might gladly have been delivered of it at an earlier period, has, in the end, no choice left; for, when once it bursts into carious ulceration, it never heals, the fetor is inconceivably overbearing, attended with hectic. You are also to remark, that, when such disease takes place in the hand itself, the joints of each of the fingers grow out into tumours, at first of a heart-like form, corresponding with the articulations of the finger bones; but, in process of time, they grow to globular, irregular, and almost transparent tumours, still firm, or, at least, of a cartilaginous firmness. The whole hand degenerates into a deformed mass, discoloured, ulcerated, and fetid; from the individual knobs of which deformed mass, the points of the respective fingers project like griffin's claws, with crooked nails of enormous length.” Page 58—60.

The foregoing passage makes us tolerably well acquainted with Mr. John Bell's sentiments relative to the pathology of exostoses, and though we do not ourselves adopt some of his conclusions, nor think that all bony tumours coincide with his account, yet many cases certainly answer the description which he has given.

Some exostoses cannot be discovered before the patient's death. Such was the case referred to by Boyer, of a person whose parietal bone was found after death to be three times thicker than natural. A similar case is also related in the memoirs of the academy of Dijon. In the latter example, the patient died from an exostosis on the internal side of the os pubis. The tumour, by pressing on the neck of the bladder, prevented the passage of the urine, and the introduction of the catheter.

Boyer notices the possibility of mistaking the head of a luxated bone for an exostosis. He informs us, that this happened with a young man, whose clavicle was dislocated at the end, which is articulated with the sternum. The tumour, formed by the end of the displaced bone, was mistaken for an exostosis, and was treated as such, of course, with no benefit.

Boyer also adverts to the liability of mistaking the enlargements

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enlargements of the ends of ricketty bones for exostoses. Fungous excrescences of the dura mater might likewise (as the same author explains) be erroneously conceived to be exostoses; for, after they have destroyed a part of the bones of the cranium, they form an external protrusion. Their real nature, however, may be easily discriminated by attending to their consistence and progress, and particularly their pulsatory motion, which corresponds with the action of the arteries in general. We need not here say more concerning these swellings, as they are already described in another part of this Cyclopædia. See DURA MATER, *Tumours of*.

There are certain symptoms which may be said to be common to all exostoses; such are, a swelling; a sense of weight; pain, or at least a degree of uneasiness arising from the morbid action; and deformity.

Another class of symptoms may be called *particular*, because they are entirely dependent on the situation of the tumour. Thus, as Boyer observes, and as we have related in the article EXOPHTHALMIA, if an exostosis were to take place in the orbit, the eye would necessarily be expelled from that cavity. An exostosis arising from the inner surface of the clavicle, or sternum, might occasion pressure of considerable blood-vessels, and on the thoracic viscera, so as to induce a train of very dangerous and even fatal consequences.

An exostosis, arising from the internal side of the os pubis, may give rise to a fatal retention of urine, as, indeed, we have already detailed. A similar tumour, similarly situated, might also render parturition, in the natural way, impossible.

The generality of surgical writers represent scrofula as being a cause of exostoses. This statement, however, seems to rest on no foundation whatever. The swelling of the joints, when they are affected with scrofulous disease, is not produced by an expansion of the bones themselves, but altogether by a thickening of the soft parts, sometimes conjoined with a collection of a fluid resembling glair, or of purulent matter in the capsular ligament. The head of a bone, really enlarged from scrofula, has never yet been demonstrated, and cannot be found in any of the collections of morbid preparations in the various museums. The particular form of disease, with which scrofula affects the bones, we shall describe in speaking of the *White Swelling*.

A scorbutic diathesis is also set down by authors as sometimes exciting the growth of exostoses: on this point, we can only profess our ignorance of any rational evidence in favour of the opinion.

The venereal disease does undoubtedly occasion one sort of exostoses, denominated *nodes*; but, these we shall dismiss from present consideration.

It is painful for us to be obliged to acknowledge, that we are almost in total ignorance, in regard to the causes of exostoses; for, excepting contusions and fractures, which sometimes unquestionably lead to the production of bony tumours, we have no certain knowledge of any others.

Mr. John Bell informs us, that he has seen a woman's ankle fall into this disease, in consequence of a very trivial accident; the tibia and fibula grew into a common tumour, the bones seemed annihilated, and a large osseous shell appeared to be substituted in their place. In the course of the disease, the leg became twisted round in a singular manner, and enlarged to the size of a pillow of a settee. The woman died of hectic from the open caries of the tumour. The same author remarks, that the wrist, which is more exposed to sprains and fractures, is most liable to be thus deformed and ruined. He represents the hand

itself as being also particularly subject to similar disorder. The original injury is some slight blow, or sprain; one finger is first deformed; joint after joint enlarges; one finger after another becomes crooked; the nails project like talons, and force their way into the very flesh of the swelled and ulcerated hand, which, according to Mr. John Bell, they sometimes penetrate through and through. At length, the hand degenerates into an unwieldy and irregular mass, studded with knobs and bony tumours. This surgeon tells us, also, that in consequence of a neglected fracture of the collar-bone, in a stout young man, he once saw a tumour produced; partly consisting of bone, and partly of cartilage, rising to the height of six inches, of round figure, and insulated, moving when the arm was moved, too large and too critically situated over the axillary artery, to admit of extirpation, and which Mr. John Bell doubts not has by this time become curious, and occasioned death.

When exostoses originate from external violence, the exciting cause is involved in no obscurity; but the causes in most other instances seem to baffle all human research. Frequently, a constitutional disposition to the formation of bony tumours, in various parts of the body, seems to prevail. Mr. Samuel Cooper, in his "Dictionary of Practical Surgery," quotes an example of a boy, who came out of Cornwall, so excessively afflicted with an apparent propensity to exostoses, or an exuberant deposition of bony matter, that a very trifling blow would occasion a bony swelling on any bone of his body. The ligamentum nuchæ was ossified, and prevented the motion of his neck; the margins of the axillæ were also converted into bone, so that the poor lad was, as it were, completely pinioned.

There is one species of exostosis remaining to be noticed, which is of a very peculiar kind, as it is in its appearance exceedingly like a bony fungus.

A striking instance of such a disease has been recorded by Mr. Abernethy. The case being highly interesting, we shall take the liberty of quoting it. The patient, who was 34 years of age when the account was written, perceived, when about ten years old, a small tumour on his left cheek, which gradually attained the size of a walnut, and then remained for some time stationary. About a year afterwards, the tumour having again enlarged, a caustic was applied to the integuments, so as to expose the bone. The actual cautery was next applied, and an opening thus made into the antrum. After the exfoliation, the antrum became filled with a fungus, which rose out upon the cheek, and could not be restrained by any applications. Part of the fungus also made its way into the mouth, through the socket of the second tricuspid tooth, the other teeth remaining natural. The disease continued in this state nine years, occasionally bleeding in an alarming way. When the patient was in his 20th year, the whole fungus sloughed away during a fever, and did not return. After this, the sides of the aperture in the bone began to grow outwards, forming an exostosis, which grew to a great magnitude. A small exostosis took place in the mouth, but became no larger than a horse-bean. The exostosis of the maxillary bone was of an irregular figure, and projected from the whole circumference of the aperture a great way directly forward. Mr. Abernethy compares its appearance, when he was writing, with that of a large tea-cup fastened upon the face, the bottom of which may be supposed to communicate with the antrum. The diameter of the cup, formed by the circular edge of the bone, was three inches and a half: the depth two inches and seven-eighths. The general height of the sides of the exostosis, from the basis of the face, was two inches; its walls were not thick, and terminated in a thin circular edge. The integuments,

teguments, as they approached this edge, became extenuated, and they extended over the edge into the cavity. The exostosis reached to the nose in front, and to the masseter muscle behind; above it included the very ridge of the orbit, and below it grew from the edge of the alveolar process. A line that would have separated the diseased from the sound bone, would have included the orbit and nose, and indeed one half of the face. Mr. Abernethy saw no means of affording the man relief. *Med. Chirg. Transf.* vol. 2.

In regard to the treatment of exostoses, it is exceedingly difficult to lay down any determinate rules. With the exception of venereal nodes, we cannot say that we are acquainted with any remedy which has the power of diminishing bony tumours. Perhaps blisters kept for a long while open, by means of the savin cerate, and applied to the nearest surface of the integuments, might have the effect of exciting the action of the absorbents, so that the deposited bony matter would be at least in part removed. That blisters would operate in this manner, we may conclude from their having been known to diminish the swelling of venereal nodes, after mercury has ceased to be productive of any benefit. However, we do not mean to represent this plan as likely to answer fully in practice; for, even were it to prove successful, it could only be after such time and perseverance as few patients would allot.

The chief method of getting rid of an exostosis is by attacking the tumour with a cutting instrument, and it is obvious that this mode of proceeding cannot be adopted, except when no anatomical considerations forbid it. Hopes of its success, also, should never be sanguine; because, though you may succeed in removing every particle of the bony swelling, still the deposition of bone may continue, and the disease recur, and this even in a more malignant form.

When an exostosis has acquired much magnitude, it seldom admits of being cut, or sawn away. But there are exceptions to this remark; for Heister records an example of an exostosis, situated on the middle of the sternum, and as large as a child's head, being successfully extirpated. If an exostosis were to be met with, growing on the middle part of one of the long cylindrical bones, with rather a narrow base, an attempt might be prudently made to remove the tumour, notwithstanding its size might be very great. When the attachment of the swelling is on the head of a bone, near a large joint, an endeavour to extirpate the disease is much more dangerous.

It would be in vain to pretend to detail particularly how the operator is to conduct himself in extirpating exostoses. His first object should be, if possible, to make such incisions through the soft parts as will expose the base of the tumour, so as to allow the saw to be applied to it. When this can be effected, it is manifest that the whole of the swelling may be removed by one section made with the saw. In the majority of cases, small short saws with long handles, in a word, the instruments described in Mr. Hey's "*Practical Observations in Surgery*," will be found much more proper and convenient than larger ones.

Sometimes, when owing to depth of situation, or some other anatomical reason, no direct attempt to cut through the base of an exostosis can be made, the surgeon may venture to remove the tumour by attacking its surface with trephines, the saws described by Hey, or with a gouge and mallet, as the French surgeons are so much in the habit of doing. When the consistence of the exostosis is not too hard, a strong knife may be occasionally employed for removing portions of the swelling, which purpose it will accomplish better than any saw.

The ancients, indeed, we might say several of the moderns, have attempted to destroy exostoses with the actual and potential cautery. Sometimes these violent means have fulfilled the object in view; but, frequently, instead of affording relief, they have killed a large portion of the bone, and converted the disease into the more afflicting one of necrosis, attended with large sores and abscesses, and often with such debility and hectic symptoms, as have ended in death.

Few good practitioners of the present day, in England, ever have recourse to this plan for the extirpation of exostoses.

When prudence prohibits an endeavour to cut away an exostosis, the disease should never be suffered to expand itself in so great a degree as to deprive the patient of the choice of parting with his limb for the preservation of his life. Amputation should always be performed ere the disorder attains this deplorable state.

We shall conclude the present article with this general observation, that if an attempt is to be made to extirpate an exostosis, let it be done at an early period of the disease, before its size is very considerable.

EXOSTRA, in the *Ancient Theatre*, a place where such parts of the play were recited as were supposed to be acted privately in the house.

EXOSTRA was likewise the name of a warlike engine used in the sieges of towns.

EXOTERIC and ESOTERIC, are terms denoting *external* and *internal*, and applied to the double doctrine of the ancient philosophers: the one was public or exoteric, the other secret, acroamatic, or esoteric. The first was that which they openly professed and taught to the world; the latter was confined to a small number of chosen disciples. This method was derived originally from the Egyptians, who, according to the united testimony of Herodotus, Diodorus Siculus, Strabo, Plutarch, &c. had a two-fold philosophy, one secret and sacred, another public and common. The same practice also obtained among the Persian Magi, the Druids of the Gauls, and the Brachmans of India. The Egyptian priests, with whom it originated, sustained the character of judges and magistrates, and probably introduced this distinction with a view to the public welfare, and to serve the purposes of legislation and government. Clement of Alexandria informs us, that they communicated their mysteries principally to those who were concerned in the administration of the state; and Plutarch confirms the same declaration. However, others have supposed that they invented the fables of their gods and heroes, and the other external ceremonies of their religion, to disguise and conceal natural and moral truths; but whatever was the motive of their practice, it was certainly applied to political purposes. See ARISTOTLE.

EXOTIC, Εξωτικός, a term properly signifying *foreign*, or *extraneous*, *i. e.* brought from a remote or strange country. In which sense we sometimes say, *exotic*, or *barbarous terms* or *words*, &c.

The word is derived from the Greek, ἐξω, ἐξωθεν, *extra*, *without*, *on the outside*.

EXOTIC is chiefly applied to plants which are natives of foreign countries, particularly those brought from the East and West Indies, and which do not naturally grow in Europe.

The generality of exotics, or exotic plants, do not thrive in England without some peculiar care and culture; they require the warmth of their own climates, whence the use of hot-beds, glass-frames, green-houses, &c. See GREENHOUSE and STOVE.

In sending plants from one country to another, particular cautions are necessary. The plants sent from a hotter country to a colder, should be always put on board in the spring of the year, that the heat of the season may be advancing as they approach the colder climates; and on the contrary, those which are sent from a colder country to a hotter, should be sent in the beginning of winter.

The best way of packing up plants for a voyage, if they be such as will not bear keeping out of the earth, is to have boxes with handles, filling them with earth, and planting the roots as close together as may be; the plants should be set in these boxes three weeks before they are to be put on board; and in good weather they should be set upon the deck, and in bad removed, or covered with a tarpaulin.

If they are going from a hotter country to a cold one, they must have very little moisture; if, on the contrary, they are going from a colder to a warmer, they may be allowed water more largely, and being shaded from the heat of the sun, they will come safe.

Many plants, however, will live out of the earth a great while; as the sedums, euphorbiums, ficoides, and other succulent ones. These need no other care than the packing of them up with moss in a close box, and there should be a little hay put between them, to prevent them from wounding or bruising one another, and holes bored in the boxes to keep them from heating and putrefying. In this manner they will come safe from a voyage of two or three, or even four or five months.

Several trees also will come safely in the same manner, taking them up at a season when they have done growing, and packing them up with moss. Of this sort are oranges, olives, capers, jasmines, and pomegranate-trees. These, and many others, are annually brought over thus from Italy; and though they are three or four months in the passage, seldom miscarry. And the best way of sending over seeds is in their natural husks, in a bag, or packed up in a gourd-shell, keeping them dry, and out of the way of vermin. Miller.

Dr. Lister has a discourse in the *Philosoph. Trans.* on Exotic Diseases, *i. e.* such diseases as are never bred among us, but brought, from time to time, by infection from other countries. Such, according to this author, are, 1. The plague, which is properly a disease of Asia, where it is epidemic. 2. The small-pox, which is an Oriental disease, and not known to Europe, or even Asia Minor or Africa, till a spice-trade was opened to the remotest part of the Indies, whence it originally came, and where it still rages more cruelly than among us. 3. The griping of the guts, which he takes for a disease peculiar to the West Indies, and yearly received from thence: for this, he adds, is a quite different disease from the tormina ventris of the ancients, and is scarce ever known in the midland counties, or far in the north of England.

EXOUCONTII, in *Church History*, a kind of Arian heretics, who maintained that the Son of God was made out of nothing: *i. e.* Ἐκ τῶν ἐκ οὐκέν, supposed by Gothofred to be the same with the Exocionitæ; but this opinion is contradicted by the authority of Theodoret.

EXPAND, in a *Military Sense*, relates to the exterior of a line or front, either for the purpose of occupying a greater space, or in order to outflank the enemy, thereby to beat in his wings upon his centre.

It is often of the greatest importance to present a more extended line of fire, especially if it can be directed towards any particular spot; for instance, when a column is issuing from a defile, a detroit, or pass, the enemy will certainly

endeavour to pour upon its front as heavy a fire as the space may allow,

Thus, he will probably oppose a formidable cannonade thereto, so that the shots may range along the column, doing great havoc therein, not only among the soldiery, but destroying the cattle, and disabling the artillery. The rest of the field he will generally occupy in an infected form, presenting a crescent; much the same as that opposed to the immortal Nelson in his last victory! By this means every musket becomes obnoxious, each being levelled at the head of the column.

If we imagine 3000 men to be drawn up in such a manner as may produce this effect, and that five or six guns are brought to bear as above described, with perhaps a body of cavalry ready to charge in flank, when the column may have proceeded to contend with the centre of the opposing force, we shall then see how necessary it is for the column to expand with all possible celerity, and not to attempt such an attack before a sufficient front can be formed to make it with effect.

The mode of expanding may be seen under the article DEPLOY, where this particular operation will be found more fully described. We shall in this place remark, that expansion is by no means proper where the enemy can bring a large body of cavalry to act in an open country, unless an equal number of such troops may be at hand to oppose them.

Where a line of intrenchments is to be carried, expansion is not eligible; yet the concentration must be managed with peculiar care whenever the enemy may be able to line their works with artillery, especially howitzers of large calibre, which, by pouring grape among close bodies of men, would soon thin their ranks, and probably occasion, what is delicately called, "a precipitate retreat." The best authorities instruct us to say, that nine battles in ten are lost by allowing the troops to be too expanded: in such a condition they are every where weak; whereas, when properly concentrated, they are every where formidable.

We may from this collect, that allowing an army to cover too great an expanse, is, generally speaking, exposing it to ruin; it enables the enemy to force a line in whichever quarter they may judge proper, and, after forcing it, to cut up the several parts in detail. Hence, blockades are, with few exceptions, extremely dangerous, as may be better understood by reference to *environ*, which see.

When a column is to expand or deploy, or when an augmentation of front is to be made, such ought to be done with great promptness, and under a heavy fire from each division, so fast as it can arrive at its station in the line. By this means, especially if the wind be favourable, the whole may be done under cover of the smoke, and the enemy may be so rapidly gained upon, as in turn to render it necessary for him to change position; but without great coolness and firmness, nothing will be effected.

EXPANDING RIGGER, or *Drum*, in *Mechanics*, is a wheel, or rigger, to receive an endless rope, which can be enlarged or diminished in its diameter, to give a greater or less velocity to the rope.

The common expanding rigger is a cast-iron wheel with twelve arms, in each of which a groove is formed, extending nearly from the centre to the circumference, as *AA*, *fig. 5. Plate XXVI. Mechanics*. Against each arm a piece of wood is placed, which has a rebate fitting into the groove, and a screw-bolt passing through both wood and the arm of the wheel; a nut screwed upon the bolt fastens the bolt and wood at any place in the groove: each piece of wood has a groove in it to receive the rope which passes round the

wheel. The diameter of this rigger can be altered by loosening the nuts, then placing the pieces of wood all in one circle of the proposed diameter, and fastening them there by the nuts. To facilitate the placing of the pieces of wood in one circle, each arm is divided into inches, and numbered from the centre.

Mr. Andrew Flint, of London, lately received a premium of fifty guineas from the Society of Arts, for two expanding band wheels, or riggers. *Figs. 5, 6, and 7*, are different views of the first of these; *A A* is a cast metal wheel with twelve arms, each divided by a groove from near the centre to the circumference: these grooves receive rebates on the backs of twelve racks *a a*, *figs. 6 and 7*, which have projecting pieces *b, b*, with grooves to contain the endless rope *d d*. In *fig. 5*, which is a back view of the wheel *ee*, are nuts, which draw up the racks to slide in the grooves without shake, yet freely to and from the centre: the racks are moved all together by means of a circular plate *dd*, which has a spiral rib upon it entering between the teeth of each rack, so that when the plate is turned round, all the racks move to or from the centre at once: the spiral plate *dd* is screwed to an iron cross, which fits upon the axis *ff*, and is turned round by a pinion *g* of six teeth, working into a ring of teeth made in the inside of the spiral plate *d*.

Another method of accomplishing the same object is by means of twelve screws *h* (*figs. 8. and 9*) pointing to the centre of the wheel; they are all moved together by means of equal bevelled wheels fixed on them; by this means the screws are turned about contrary ways alternately: they must, therefore, be alternately cut right handed and left handed, that they may produce the same effect. The screws are turned, when the diameter of the rigger is to be altered, by a winch put upon any of the three squares *h, h, h*, on the ends of the screws. In this machine the number of screws must be even.

*Figs. 10, 11, and 12*, are drawings of an expanding rigger contrived by the writer of this article: it consists of two wheels of cast-iron *A, A*, (*figs. 10, 11, and 12*.) which have sixteen sectorial apertures marked *a*, which leave sixteen arms between them; the arms and the spaces are exactly equal, and each arm has a triangular piece of wood *b d e*, (*fig. 12*.) screwed upon it, by four screws going through the arm into the wood, which is also kept firm and perpendicular to the face of the wheel, by a rib *f*, (*fig. 11*.) which projects from each arm, and is let into a groove cut in the wood. The wheels have sockets *g, g*, (*figs. 10 and 12*.) which are bored out with a very true cylindrical hole to receive the shaft or spindle *B B* of the rigger, which is turned in the lathe to fit the sockets without shake, yet at the same time allowing them to move backwards and forwards upon the axis *B B*. The wheels are put together upon the spindle facing each other, the wooden triangles of one wheel entering the space between the arms of the other, as is shewn in *figs. 10 and 12*; in this manner it is plain that the points, or rather plane, of intersection of the triangles *b d e* of each wheel, will form a circular groove to receive a rope, which groove can be increased in its diameter by advancing the wheels towards each other, or diminished by setting them farther apart, as in *fig. 10*. The wheels are prevented from turning on the spindle by means of a fillet, which is inserted partly into a groove cut in the axis, and partly in another groove made in the socket of the wheel. The wheels may be brought nearer together, or thrown farther apart, by two screws *h, h*, (*fig. 12*.) which have sockets in one wheel, and are tapped into the other: two equal cog-wheels *i, i*, are keyed fast upon the screws, and an intermediate cog-wheel *k*, placed loosely upon the main axis

between them, causes both screws to turn at the same time. A more simple method of altering the diameter is by pushing the wheels together by hand, and fastening them to the axis by screws *e, e*, *fig. 10*.

EXPANSION, in *Metaphysics*, expresses the idea we have of lasting or preserving distance, *i. e.* of distance, all the parts whereof exist together.

EXPANSION, from the Latin *expando*, in *Philosophy*, denotes the increment of surface or of bulk, of which natural bodies are susceptible. With respect to the expansion of surface, see the articles DUCTILITY and GOLD *Beating*.

Bodies of every kind, as far as we are acquainted with them, are expanded in bulk by heat, and are contracted by cold; and to this law there are very few exceptions, which will be noticed in due time. The expansions, or the increments of bulk, are not exactly proportional to the increments of heat in the same body; nor are different bodies expanded alike by the like elevation of temperature. Thus, if a quantity of water be increased one inch in bulk, by the communication of ten degrees of heat, the communication of twice or thrice as much more heat will not cause it to expand two or three inches more. Also, if a rod of gold, and another similar rod of glass, be heated to the same degree, their increments of bulk, arising thereby, will not be equal, the gold expanding more than the glass.

Of the three principal states of natural bodies, *viz.* solids, liquids, and elastic fluids, the solids are expanded least; the liquids are expanded more than the solids, but the elastic fluids are expanded a vast deal more than the liquids. The knowledge of the precise quantities of these expansions of bodies is of great use in philosophy, in mechanics, and in other scientific subjects; hence no pains have been spared by philosophers to investigate and ascertain them; various instruments have been contrived for that purpose; innumerable experiments have been instituted; and a great many useful results have been obtained. Of these results we shall now endeavour to give a regular and distinct account.

The instruments which have been contrived for the purpose of measuring the expansions of solids arising from an elevation of temperature, are called *pyrometers*. The objects which must be had in view in the construction of pyrometers, are to form a steady frame, wherein solids of a certain length may be applied either successively, or several of them at the same time, some contrivance by which those metallic bodies may be heated to any required degree, and a mechanism capable of measuring the increase of bulk which is caused by the heat; and this may be accomplished by means of multiplying wheels, by levers, by screws, by a microscopical micrometer, or otherwise. See PYROMETER.

Some of the first determinations of the expansion of bodies, that may be considered as being sufficiently accurate, were made by Mr. Ellicot with a pyrometer of his contrivance. Mr. Ellicot determined the proportional expansions of seven metallic bodies by the same elevation of temperature. They are as follows:

Gold.	Silver.	Brass.	Copper.	Iron.	Steel.	and Lead.
73.	103.	95.	89.	60.	56.	149.

Mr. Smeaton contrived a much better pyrometer, and with it he determined the expansions of several solids. Mr. De Luc also contrived a pyrometer of a peculiar construction; but Mr. Ramsden's pyrometer is superior to any other contrivance of the kind.

The following table shews, in parts of an inch, how much one foot length of different substances is expanded by 180° of heat, Fahrenheit's scale, between the freezing and the boiling

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boiling points of water. To the first seven substances, (which were examined in Mr. Ramsden's most accurate pyrometer,) there are added the expansions for a single degree of heat. The others were determined by Mr. Smeaton with his pyrometer.

Fahrenheit's Scale.

	Fahrenheit's Scale.	
	By 1°	By 180°.
Standard brass scale, supposed to be Hamburgh brass - - -	0.0001237	0.0222646
English plate brass in form of a rod - - - - -	0.0001262	0.0227136
English plate brass in form of a trough - - - - -	0.0001263	0.0227386
Steel rod - - - - -	0.0000763	0.0137368
Cast-iron prism - - - - -	0.0000740	0.0133126
Glass tube - - - - -	0.0000517	0.0093138
Solid glass rod - - - - -	0.0000539	0.0096944
White glass barometer tube - - -	- - -	0.0100
Martial regulus of antimony - - -	- - -	0.0130
Blistered steel - - - - -	- - -	0.0138
Hard steel - - - - -	- - -	0.0147
Iron - - - - -	- - -	0.0151
Bismuth - - - - -	- - -	0.0167
Copper hammered - - - - -	- - -	0.0204
Copper eight parts, with tin one part - - - - -	- - -	0.0218
Cast brass - - - - -	- - -	0.022
Brass sixteen parts, with tin one part - - - - -	- - -	0.0229
Brass wire - - - - -	- - -	0.0232
Speculum metal - - - - -	- - -	0.0232
Spelter solder, viz. brass two parts, zinc one - - - - -	- - -	0.0247
Fine pewter - - - - -	- - -	0.0274
Grain tin - - - - -	- - -	0.0298
Soft solder, viz. lead two parts, tin one - - - - -	- - -	0.0301
Zinc eight parts, with tin one, a little hammered - - - - -	- - -	0.0323
Lead - - - - -	- - -	0.0344
Zinc or spelter - - - - -	- - -	0.0353
Zinc hammered half an inch <i>per</i> foot - - - - -	- - -	0.0373

Iron, instead of being condensed into a smaller bulk, expands in its transition from a fluid into a solid state; so that a quantity of iron occupies more room in the solid form than it does in a fused state.

Dr. Wollaston, in order to form some estimate of the comparative rate of expansion of platina and palladium, says, "I rivetted together two thin plates of platina and palladium, and observing that the compound plate, when heated, became concave on the side of the platina; I ascertained that the expansion of palladium is in some degrees the greater of the two. By a similar mode of comparison I found that palladium expands considerably less than steel by heat." Phil. Trans. for 1805.

It must be remarked with respect to the expansion of glass, that sometimes glass tubes are extended more than solid glass rods: their dilatation, however, is not constant; for tubes of different diameters, or of different sorts of glass, are expanded differently by the like degrees of heat.

Wood is not expanded much longitudinally; that is, in the direction of its fibres, by heat, and this is particularly the case with deal and other straight-grained wood. Pro-

bably, upon the whole, the longitudinal expansion of wood is less than that of glass. It has been observed, (especially by Dr. Rittenhouse, Trans. of the American Phil. Society) that very dry and seasoned wood, if not exposed to a very high or to a very low temperature, will expand in length pretty regularly: otherwise its expansion by heat, and its contraction by cold, are very irregular: for they seem to depend partly upon the heat, and partly upon the moisture, which the wood acquires in certain circumstances, and is deprived of in others.

It is hardly necessary to mention, that the solids of the preceding table contract their dimensions by cooling as much as they are expanded by heating; thus, for instance, if a yard length of any particular metallic body, by being heated 100° above the actual temperature of the atmosphere, be lengthened one fiftieth part of an inch; afterwards, when cooled down to the temperature of the atmosphere, it will be found to have lost exactly that fiftieth part of an inch which it had acquired by heating.

From the experiments hitherto made on the expansions of solids by heat, no correspondence has been observed between the expansions and the quantities of caloric they are capable of absorbing. The fusibility of metals seems to coincide with the dilatations; platina, the least fusible of the metals, dilates the least; lead dilates most; and the most fusible glass is also the most dilatable. We may therefore conclude with Mr. Berthollet, that bodies are so much the more expandible, the less caloric they require to change their constitution from solid to liquid, and from liquid to gases or vapours.

There is a substance which expands when heated; but does not contract when cooled; and of this singular property Mr. Wedgwood availed himself for the construction of his ingenious thermometer for measuring the highest degrees of heat; viz. those degrees which exceed the scale of the mercurial thermometer. (See THERMOMETER.) The substance alluded to is the argillaceous earth or clay, and it appears that the above-mentioned property belongs, more or less, to argillaceous bodies of every kind. This property may at first sight appear to be an unaccountable exception from the general law: the difficulty, however, will vanish, if it be considered that bodies of the argillaceous genus contain a considerable quantity of water, and that the contraction of these bodies, when exposed to the action of a strong fire, is in great measure due to the escape of the water, and hence they do not contract by subsequent cooling.

The method of measuring the expansions of fluids is to inclose them in a certain vessel, and to measure that part of the cavity of the vessel, which is occupied by the fluid under trial, in different temperatures. It is evident that the substance of the vessel is likewise expanded by the heat, and of course the cavity of the vessel is enlarged. Therefore, when we find that the bulk of the fluid is increased, that increment is only the difference between the enlarged capacity of the vessel and the increased bulk of the fluid. This shews the necessity of forming those vessels of such substances as are least expandible by heat. Indeed glass is the substance which is universally used for such purposes, both on account of its little expandibility, and of its transparency; besides its having other useful properties. A glass vessel, filled to a certain degree with a liquid, for the purpose of shewing the expansions of that liquid in different temperatures, or for the purpose of shewing the temperature of the corresponding expansion of that liquid, is called a thermometer; viz. a measure of the temperature. See THERMOMETER.

The properest shape for a thermometer is that of a long tube

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tube with a narrow bore, having a globular cavity at one end; which, familiarly speaking, may be called a globular glass bottle with a long and narrow neck. The globular cavity, and part of the tube of one of these vessels, is filled with the liquor whose expansion is to be examined, and the vessel is then heated, in consequence of which the liquor, which is contained in it, is expanded, and not being able to extend itself any other way, all the increment of bulk must be manifested in the tube; *viz.* the surface of the fluid will rise in the tube; or, if cooled, it will descend in it. If the same vessel of the above-mentioned shape be successively filled with different fluids, and with each fluid it be exposed to certain degrees of temperature, (which must be determined by an accurate thermometer,) the proportional expansions of the different fluids may thereby be ascertained. The same object may be obtained by filling several such vessels with the different fluids, that are to be examined, and heating or cooling them all at the same time; but in this case the corresponding capacities of the different vessels must be previously ascertained; which may be done by filling all the vessels with the same kind of fluid, and exposing them all to different degrees of temperature; so that the corresponding elevations of the fluid in the different vessels may be marked on the tubes. These vessels are afterwards emptied and filled again with the fluids, &c. Thus the proportional expansions of liquids may be determined; but when the actual or absolute increase of bulk is required, then the capacity of the vessel must be accurately gauged. This measurement of the capacity may be accomplished in the following manner. In the first place weigh the empty glass tube; secondly, fill part of the tube with a convenient fluid, (mercury, for instance, which is the fittest for such purposes); thirdly, measure the length of the tube which is occupied by the mercury, and weigh the instrument a second time; then, by subtracting this second weight from the former, you will have the weight of mercury which fills up a certain length of the cavity of the tube; fourthly, fill the bulb of the vessel entirely with mercury, and weigh the vessel a third time. This weight being subtracted from the first, *viz.* from that of the empty vessel, will leave the weight of the mercury in the bulb. Now, having the weight of the mercury in the bulb, as well as of that which fills a certain length of the tube, the ratio of the former to the latter may be easily determined by simple division. Also the absolute quantity in bulk of the former is obtained from the well known specific gravity of mercury, and from the weight of a cubic inch of distilled water, which (when the barometer is at 29.74 inches, and Fahrenheit's thermometer at 66°) is equal to 252.42 grains Troy; one pound Troy being equal to 5760 of those grains. An English cubic inch of mercury of the specific gravity 13.6 weighs 3443.2 English grains. Instead of mercury, some other fluid may be employed for this purpose; but not so conveniently as mercury. The expansions of a fluid, which are caused by different degrees of heat, may likewise be determined by ascertaining the specific gravity of that fluid in different temperatures; for the specific gravity decreases in proportion as the fluid is expanded, and *vice versa*; but this method is not capable of as much accuracy as the former.

Liquids differ from each other in regard to their expansibility; some expanding more than others. Also the expansions of the same liquid by equal degrees of heat are not quite regular; and it has been observed that this irregularity is greater when they approach the state of vapour. Upon the whole, mercury has been found to be expanded by

heat more regularly than any other fluid; yet its increments of bulk are not perfectly regular. Mr. De Luc, with great care and patience, has endeavoured to ascertain the real expansibility of mercury, or rather the real quantities of heat that are required for expanding mercury arithmetically, *viz.* by equal augmentations. These are expressed in the following table, the first column of which contains the degrees of Reaumur's scale, from five to five, which are equal parts; the second shews the real quantities of heat which are required to raise the mercury to the corresponding degrees, where *z* is a fixt but unknown quantity; and the third column shews the differences of those quantities. De Luc's Recher. sur les Modif. de la Atmosph. 1772, p. 309.

	Mercurial Thermom.	Real quantities of heat.	Real differences of heat corresponding to the variations of the Mercury in the thermometer from 5 to 5 degrees.
Point of boil. water	80°	<i>z</i> + 80.00	
	75	<i>z</i> + 75.28	-4.72
	70	<i>z</i> + 70.56	-4.72
	65	<i>z</i> + 65.77	-4.79
	60	<i>z</i> + 60.96	-4.81
	55	<i>z</i> + 56.15	-4.81
	50	<i>z</i> + 51.26	-4.89
	45	<i>z</i> + 46.37	-4.89
	40	<i>z</i> + 41.40	-4.97
	35	<i>z</i> + 36.40	-5.00
	30	<i>z</i> + 31.32	-5.08
	25	<i>z</i> + 26.22	-5.10
	20	<i>z</i> + 21.12	-5.10
	15	<i>z</i> + 15.94	-5.18
	10	<i>z</i> + 10.74	-5.20
	5	<i>z</i> + 5.43	-5.31
Point of melt. ice	0	<i>z</i>	-5.43

From the third column it appears, that the differences of heat requisite to make equal and progressive additions to the bulk of the mercury, though not exactly equal, yet are not very far from the ratio of equality. If the bulk of a quantity of mercury, at the temperature of 32° Fahrenheit's scale, be conceived to be divided into 100,000 equal parts, and then be heated as high as the temperature of boiling water; (*viz.* 212°) its bulk will thereby be increased by 1836 of those parts.

The expansion of water is attended with a singular deviation from the general law; *viz.* this fluid is expanded by heat from about the 40th degree of Fahrenheit's thermometer upwards; but below 40° its bulk is expanded by a farther decrease of heat, or increase of cold; and in fact ice is lighter than water, so as to float upon it; the specific gravity of ice being to that of water nearly as 7 to 8. The bulk of ice is to that of the water, when the ice is melted, as 9 to 8 very nearly. The bulk of water, from its most contracted state at the temperature of 40°, increases continually; but that increase is not very regular; for instance, the increase of bulk from 180° to 212°, is considerably greater than from 40° to 72°. If the bulk of water at 40° be called 1, its bulk at 212° will be 1.04785. Beyond that degree of heat water becomes vapour; *viz.* an elastic fluid, and the formation of this elastic fluid on the sides of the vessel within the water, forms the bubbles, the escape

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of which constitutes the boiling. The bulk of steam at the boiling point is somewhat less than 1800 times the bulk of the water from which it originated.

The expansion of freezing water is not owing to the extrication of air; for water deprived of air expands like other water in freezing. Mr. Mairan attributes it to a strong tendency the particles of water have to arrange themselves into ranks and lines, which cross one another at angles of 65° and 120°. This tendency seems to begin at the temperature of 40°. The expansion of freezing water has a prodigious force. It is owing to this that in hard frosts timber is burst, plaster is removed from walls, and even iron mortar shells filled with water, and accurately stopped, have been burst by the freezing of the water.

This singular property of water, viz. its expanding from the temperature of 40° downwards, so as to become lighter and lighter in proportion as it becomes colder and colder, is a most striking instance of the wisdom of the Creator, and is a property of immense consequence to the very existence of animals and vegetables. A quantity of water is indispensably necessary to animals and to vegetables at all times of the year. In winter, when the cold air freezes the surface of the water, that effect seldom penetrates lower than two or three feet. Below that depth the water continues fluid, and the crust of ice itself contributes to preserve its fluidity. The heat of the earth, which has been acquired during the summer, undoubtedly prevents the formation of ice below a certain depth. But if water in cooling had continued to increase in specific gravity, and had ice been actually heavier than water, the heat of the earth would not have been sufficient to prevent the total freezing of all the waters of lakes, seas, rivers, &c. "For," says count Rumford, "as the particles of water on being cooled at the surface would, in consequence of the increase of their specific gravity, on parting with a portion of their heat, immediately descend to the bottom, the greatest part of the heat accumulated during the summer in the earth, on which the water reposes, would be carried off and lost before the water began to freeze; and when ice was once formed, its thickness would increase with great rapidity, and would continue increasing during the whole winter; and it seems very probable that in climates which are now temperate, the water in the large lakes would be frozen to such a depth in the course of a severe winter, that the heat of the ensuing summer would not be sufficient to thaw them; and should this once happen, the following winter would hardly fail to change the whole mass of its waters to one solid body of ice, which never more could recover its liquid form, but must remain immovable till the end of time." (7th Essay.)

The following table shews the expansions of the principal liquids that have been submitted to such experiments, according to Mr. De Luc's observations. With respect to this table it must be understood that different thermometers (each being filled with a particular fluid, such as is mentioned at the top of each column, and each being divided into 80 equal parts between the freezing and the boiling points of water) are placed with their bulbs in the same vessel full of water, and that the water is gradually heated. When the mercurial thermometer stands at 5°, 10°, 15°, &c. the surfaces of the fluids in the other thermometers will be found at the degrees which stand on the same levels; for instance, when the mercurial thermometer stands at 40°, the water thermometer will be found to stand at 20°.5, the spirit thermometer will be found to stand at 35°, the oil thermometer at 39°.2, &c.

	Mercury.	Water	Water saturated with salt.	Alcohol.	Alcohol 3 parts, water 1.	Alcohol and water equal parts.	Alcohol 1 part, water 3.	Oil of olives.
Boiling water	80°	80.0	80.0	80.0	80.0	80.0	80.0	80.0
	75	71.0	74.1	73.8	73.7	73.2	71.6	74.6
	70	62.0	68.4	67.6	67.5	66.7	62.9	69.4
	65	53.5	62.6	61.5	61.5	60.6	55.2	64.4
	60	45.8	57.1	55.5	55.8	54.8	47.7	59.3
	55	38.5	51.7	50.3	50.2	49.1	40.6	54.2
	50	32.0	46.6	45.1	44.9	43.6	34.4	49.2
	45	26.1	41.2	40.0	39.7	38.4	28.4	44.0
	40	20.5	36.3	35.0	34.8	33.3	23.0	39.2
	35	15.9	31.3	30.1	29.8	28.4	18.0	34.2
	30	11.2	26.5	25.5	25.2	23.9	13.5	29.3
	25	7.3	21.9	20.9	20.7	19.4	9.4	24.3
	20	4.1	17.3	16.5	16.2	15.3	6.1	19.3
	15	1.6	12.8	12.0	11.8	11.1	3.4	14.4
	10	0.2	8.4	7.9	7.7	7.1	1.4	9.5
Freezing	5	0.4	4.2	3.9	3.8	3.4	0.1	4.7
	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5		4.1					
	10		8.0					

The expansions of elastic fluids, such as common air, the gases, and vapours, are more difficultly ascertained; for the expansions of those fluids are occasioned by a diminution of pressure, as well as by an increase of temperature; and it is difficult to subject any of those fluids to the action of one of these causes only at a time, in order that the effect of each may be duly estimated.

When common air is acted upon by pressure only, independent of any alteration of temperature, its bulk is found to increase and to decrease in the inverse proportion of the pressure; thus, the air close to the surface of the earth is compressed into the bulk which we experience, by the superincumbent atmosphere. If that pressure be increased, the bulk of the lower air will be contracted, which is manifested by an augmentation of its weight; if that pressure be diminished, the bulk of the lower air will be increased, as is manifested by a diminution of its weight. And this expansion and contraction of the air is exactly but inversely proportional to the pressure; so that a double pressure will compress it into half the space, a treble pressure into one third of the original space, &c. The same thing, *mutatis mutandis*, may be said of the removal of pressure, and of the expansion thereby arising. This elasticity of the air has not been found to be impaired by a long continuance of the pressure; for air has been left during several years very much compressed in proper vessels, wherein there was nothing that could have a chemical action upon it; and afterwards on removing the unusual pressure, and replacing it in the same temperature, the air has been found to recover its original bulk. It is not known how far a quantity of air may be expanded by removing the pressure, nor how much it may be compressed by increasing the pressure; for no experiments have as yet been able to ascertain either limit.

The instrument, in which the expansion of air is tried, has been called *manometer*, (which see.) It is a sort of large air thermometer, consisting of a tube five or six feet long, having a bulb at one end, and being open at the other end. The bore of the tube is about a 20th of an inch in diameter. A small quantity of quicksilver is placed in some part

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part of the cavity of the tube, and the expansion of the air in the bulb, when heated, forces the quicksilver to move towards the open end of the tube. The degree of heat to which the manometer is exposed is measured by means of a thermometer; the quantity of expansion of the air is measured by gauging the manometer, and making marks on the tube, which may indicate parts of the cavity of the tube that are proportional to the capacity of the manometer; as for instance 100ths, 1000ths, &c. By placing the manometer horizontal or vertical, either with the bulb downwards or upwards, the air in it may either be left of the natural density, or it may be condensed, or, lastly, it may be rarefied; for when the manometer stands horizontal, the quicksilver in the tube does not press upon the air in the bulb, nor on that of the atmosphere; when the bulb is downwards, the quicksilver presses upon the air of the manometer, and when the bulb is upwards, the quicksilver presses against, and counteracts, in some measure, the gravity of the atmosphere. Hence this pressure, and this expansion of the air within the manometer, may be increased to any required degree by increasing the quantity of quicksilver within the tube: and thus the expansibility of common, or of condensed, or of rarefied air, may be tried. The expansion of air, by the same degrees of heat, differs according to its density, and to the quantity of moisture it contains; nor are the increments of its bulk proportional to the degrees of temperature.

It appears from Col. Roy's very numerous experiments (Phil. Transf. vol. 67th) that 1000 parts of air, of the density of the common atmosphere, at 0° of heat, become 1484.21 at 212°; viz. are expanded 484.21, by 212° of heat.

1000 parts of air loaded with  $2\frac{1}{2}$  atmospheres, are expanded 434 of those parts, by 212° of heat.

1000 parts of air pressed only with  $\frac{1}{8}$ ths of an atmosphere, are expanded nearly 484 of those parts by 212° of heat.

1000 parts of air pressed with  $\frac{1}{4}$ th of an atmosphere, are expanded about 141 parts by 180° of heat; viz. from the freezing to the boiling point of water.

"From these last experiments," Col. Roy says, "it would seem that the particles of air may be so far removed from each other, by the diminution of pressure, as to lose a very great part of their elastic force."

The above-mentioned expansions of air are by no means regular: viz. they are not proportional to the number of the degrees of heat. The maximum of expansion takes place between 52° and 72°: and the minimum is constantly at the boiling point of water. Moist air expands a great deal more than dry air, especially when it approaches the boiling point of water; so that between 192°, and 212°, moist air expands about eight, or nine, times as much as dry air in similar circumstances.

The expansions of gases may be tried and determined in the same manner as the expansion of common air. From a long series of experiments, Messrs. Guyton and Prieur deduced a dilatation peculiar to each gas; but Mr. Guy-Lussac has shewn, that all gases, without exception, possess the same expansibility at the same degree of temperature, and that the presence of water in gases occasioned the errors into which his predecessors had fallen. He is led to conclude from his experiments made on gases reduced to the utmost degree of dryness, that 100 parts of each of the permanent gases acquire an increase of  $\frac{1}{273}$  by every degree of the thermometer from 0° to 80° Reaumur's scale. Vapours, he also thinks, follow the same laws of dilatation as gases, provided the temperature be sufficiently elevated to keep them in the elastic state. Therefore, Mr. Chaptal says, it may be laid

down as a principle, that gases and vapours are equally dilat-able, and equally compressible; but it will be necessary to be more particular with respect to the expansibility of the vapour of water, upon the elasticity of which numerous natural phenomena, and the action of several important machines, depend.

Mr. Schmidt also made a series of experiments upon the expansibility of air, made as dry as possible by exposure to hot potash. He found the expansion of a quantity of air which measured one inch at the freezing point, viz. at the temperature of 0° Reaumur's thermometer, to expand as below.

Degrees of Reaumur.	Expansion of one inch.
1	0.0044675
4	0.0178700
8	0.0357400
12	0.0536100
16	0.0714800
20	0.0893500
24	0.1072200
28	0.1250900
32	0.1429600
36	0.1608300
40	0.1787000

This table also shews, by its differing from the results of D'Amontons, De Luc, Lambert, Schuckburgh, Berthollet, and others, that those gentlemen operated upon air more or less charged with moisture. They also took the barometers at different altitudes. In Mr. Schmidt's experiments the barometer was taken at 29,841 English inches. These variations of the rates of expansibility of moist air, saturated at different temperatures, Schmidt attributes to the variations of the degrees of affinity between air and vapour.

Water heated to the 212th degree of Fahrenheit's thermometer (or thereabout, for the different gravity of the atmosphere occasions a considerable difference) overcomes the ordinary pressure of the atmosphere and becomes steam, an elastic substance, the bulk of which at that point is somewhat less than 1800 times the bulk of the water from which it originated. Beyond that point vapour is expansible in a most astonishing degree; for 30° more of heat (viz. the temperature of 242°) will double the elastic force of steam; 30° more added to that (viz. the temperature of 272°) will render the elastic force of steam nearly equal to four atmospheres; and so forth. This immense expansibility of steam, when the heat which produces it is quickly supplied, is capable of producing prodigious effects. When water is caused to boil in a vessel upon a common fire, the heat which is communicated cannot convert all the water at once into steam; but if the quantity of water be small in proportion to the heat which can be communicated in a given time, then the conversion of water into steam is quickened to any degree, and it may be rendered instantaneous; in which case it produces a sudden and violent expansion, or an explosion. A drop of rain in boiling linseed oil, falls to the bottom, is instantly converted into vapour, and occasions dangerous consequences. "It has sometimes," Dr. Black says in his Chemical Lectures, "happened that a person, by carelessly spitting into a copper foundery, has occasioned an explosion that destroyed the whole building." Count Rumford attributes the vast force of gun-powder to the sudden conversion into vapour of that quantity of water which naturally enters into the composition of that powder; it being a component of the nitre. Phil. Transf. for 1797.

## EXPANSION.

Water at the temperature of  $212^{\circ}$  is converted entirely into steam, or rather, under the ordinary pressure of the atmosphere, water cannot be heated higher than  $212^{\circ}$ ; but water is gradually converted into steam or vapour at a much lower temperature. Mr. Pictet instituted a series of experiments on the elasticity of pure vapour in low temperatures. He found that a grain of warm water in vacuo evaporates in forty minutes in the temperature of  $38^{\circ}$  Fahr. under a receiver containing 1452 English cubic inches, but that it did not diffuse itself equally in less than six hours and then raised the hygrometer from  $17^{\circ}$  to  $65^{\circ}$ , that is,  $43^{\circ}$ ; and during this whole time the cold under the receiver was constantly decreasing, though slowly: which decrease undoubtedly contributed to the diffusion of the vapour. *Essais de Physique*, p. 157.

The best, or most extensive experiments upon the expansive force of the steam of water, and of the steam of alcohol, were made by the Chev. de Bettancourt; and are related by Prony in the second volume of his "Architecure Hydraulique;" from which the following compendious sketch is derived.

The fluid with which the experiments were made was confined in a very strong copper boiler, being eight inches at its greatest diameter, and fourteen inches in height. The upper part of it was closed by a cover made of copper, through which passed three tubes. The first served to introduce the fluid into the boiler, and could be closed by means of a screw. The second was occupied by a thermometer, having its ball about two inches above the bottom of the boiler, and the scale, which was on the outside, contained from  $0^{\circ}$  to  $110^{\circ}$  of Reaumur. To the third was adapted a bent barometer tube, having two lines of internal diameter; the ascending branch of which was 110 inches in length. By means of a lateral cock a communication was established between the boiler and an air-pump, which served to make a vacuum before the fire was kindled in the furnace below the apparatus. This circumstance of evaporation in a vacuum forms an essential difference between the experiments of Bettancourt and those made before by Ziegler, and renders them applicable to the theory of the steam-engine, where the vapour acts in a space freed from air.

A vacuum having been made in the boiler, the mercury brought as nearly as possible to a level in the two branches of the barometric tube, and the thermometer reduced to zero by means of ice, the ice was removed, and a fire was kindled, which was excited gently and with much equality, that the thermometer passed over about a degree per minute. One person then stood by to observe the barometer, and another to observe the thermometer, and each kept a register from degree to degree of the pressure and corresponding temperatures; the pressure being expressed by the height, in French inches, of the columns of mercury, which rose above the level in the long branch of the barometer.

These observations of the expansive force of the steam of water furnish 110 results, proceeding from degree to degree of the thermometer, and beginning at zero. These results are contained in the following table, where the degrees of pressure are expressed in French inches of perpendicular height of mercury, and the temperature is denoted according to Reaumur's scale. The experiments on the expansive force of the steam of alcohol were made by the like process, and with the same apparatus.

TABLE of the Expansive Force of the steam of Water and of Alcohol.

Temp- ture.	Pressure.		Temp- ture.	Pressure.		Temp- ture.	Pressure.	
	Wa- ter.	Alco- hol.		Wa- ter.	Alcohol.		Wa- ter.	Alcoho-
0	0.00	0.00	37	2.45	5.55	74	20.00	48.10
1	0.00	0.00	38	2.57	6.00	75	21.75	50.20
2	0.00	0.00	39	2.75	6.45	76	22.9	52.60
3	0.00	0.05	40	2.92	6.90	77	24.15	55.30
4	0.02	0.09	41	3.10	7.35	78	25.5	57.90
5	0.02	0.12	42	3.27	7.82	79	26.67	61.00
6	0.05	0.18	43	3.47	8.37	80	28.00	63.80
7	0.07	0.25	44	3.70	8.92	81	29.60	66.90
8	0.10	0.32	45	3.95	9.48	82	31.30	69.80
9	0.12	0.38	46	4.25	10.15	83	33.00	73.40
10	0.15	0.45	47	4.45	10.80	84	34.60	76.90
11	0.18	0.50	48	4.75	11.50	85	36.45	79.60
12	0.22	0.62	49	5.00	12.20	86	38.10	83.60
13	0.27	0.72	50	5.35	12.35	87	40.00	87.10
14	0.30	0.82	51	5.70	13.75	88	42.20	90.80
15	0.35	0.93	52	6.05	14.60	89	44.30	95.00
16	0.40	1.02	53	6.50	15.50	90	46.40	98.00
17	0.45	1.12	54	6.90	16.40	91	48.40	
18	0.52	1.25	55	7.32	17.65	92	50.50	
19	0.58	1.38	56	7.85	18.85	93	53.00	
20	0.65	1.52	57	8.40	20.00	94	55.30	
21	0.75	1.65	58	8.85	21.20	95	57.80	
22	0.82	1.80	59	9.35	22.30	96	60.50	
23	0.90	1.95	60	9.95	23.70	97	63.40	
24	0.97	2.10	61	10.40	24.80	98	66.20	
25	1.05	2.32	62	11.00	26.10	99	69.00	
26	1.12	2.52	63	11.70	27.40	100	71.80	
27	1.22	2.75	64	12.40	28.90	101	75.00	
28	1.32	2.95	65	13.20	30.60	102	78.20	
29	1.42	3.20	66	13.80	32.00	103	81.00	
30	1.52	3.40	67	14.50	33.50	104	84.00	
31	1.65	3.70	68	15.25	35.10	105	86.80	
32	1.78	4.00	69	16.10	37.20	106	89.00	
33	1.90	4.30	70	16.90	39.40	107	91.30	
34	2.00	4.60	71	17.80	41.30	108	93.50	
35	2.15	4.95	72	18.70	43.50	109	95.60	
36	2.27	5.28	73	19.50	46.00	110	98.00	

The expansive force of the steam of water has also been determined by Mr. Schmidt, with all the accuracy that the experiments seem to admit of: but the results which he has not stated for every degree of the thermometer, do not agree exactly with those of Bettancourt. We deem it therefore necessary to subjoin those results in the following short table, wherein the temperature is expressed in degrees of Reaumur's thermometer, as in the preceding table, and the expansive force in French inches of perpendicular altitude of mercury.

TABLE of the Expansive Force of the pure vapour of Water, according to Mr. Schmidt.

Temperature.	Expansive Force.	Temperature.	Expansive Force.
0	0.0	22	1.01
5	0.11	25	1.30
6	0.15	27	1.42
10	0.28	30	1.93
12	0.38	33	2.23
13	0.44	35	2.68
15	0.55	37	3.20
16	0.61	39	3.40
18	0.76	40	3.64
20	0.90	80	28.00

Mr. Dalton has likewise endeavoured to determine the expansive force of the vapour of water; but the results of his experiments nearly coincide with those of the preceding tables, which supercedes the necessity of stating them in the present article. See EVAPORATION.

From a careful examination of all the experiments made on this subject, Dr. Young has deduced a formula by which the expansive force of steam may be determined for any degree of the thermometer, pretty near the real results of the experiments. The formula is as follows:

Let  $f$  denote the temperature according to Fahrenheit's thermometer, and  $e$  the number of inches in perpendicular height of mercury, which the steam is capable of supporting; then the formula is  $e = .1781 (1 + .006 f)^2$ .

The reader might perhaps expect to find in the present article the particulars relative to the expansions of heat, and of electricity; but the uncertain natures of the fluids, to which the effects of heat and of electricity are attributed, besides other considerations, oblige us to refer him to other parts of this Cyclopædia. See HEAT, CALORIC, and the articles belonging to electricity.

Dr. Gregory, in his Astron. p. 407, proves, that a globe of our air, of an inch diameter, if it were removed to the distance of a semidiameter of the earth, would expand itself so as to fill all the planetary region as far as nay, far beyond the sphere of Saturn. See AIR.

EXPANSUM FOLIACEUM. See FOLIACEUM.

EX PARTE, i. e. partly, or of one part, in Law. A commission ex parte, is that taken out and executed by one part only; where both parties join it is called a joint commission. See COMMISSION.

EX PARTE TALIS, a writ that lies for a bailiff or receiver, who, having auditors assigned to take his account, cannot obtain of them reasonable allowance, but is cast into prison. The course in this case is to sue this writ out of chancery, directed to the sheriff, to take four mainperners to bring his body before the barons of the exchequer at a certain day, and to warn the lord to appear at the same time. F. N. B. 129.

EXPECTANT FEE, where lands are given to a man and his wife, and the heirs of their bodies; in which sense it differs from fee-simple, where lands are given to a man and his wife in frank marriage, to hold to them and their heirs.

EXPECTANCY, ESTATES IN, are of two sorts; one created by act of the parties, called a remainder; the other by act of law, called a reversion. See these articles; and also ESTATE and EXECUTORY Devise.

EXPECTATION, in the Doctrine of Chances, is applied to any contingent event, and is capable of being re-

duced to the rules of computation. Thus, a sum of money in expectation, when a particular event happens, has a determinate value before that event happens; so that if a person is to receive any sum, e. gr. 10*l.* when an event takes place which has an equal probability of happening and failing, the value of the expectation is half that sum or 5*l.* and in all cases, the expectation of obtaining any sum is estimated by multiplying the value of the sum expected by the fraction, which represents the probability of obtaining it. The expectation of a person who has three chances in five of obtaining 100*l.* is equal to  $\frac{3}{5} \times 100$  or 60*l.* and the probability of obtaining 100*l.* in this case is equal to  $\frac{3}{5} = \frac{60}{100}$ .

If the obtaining of any sum requires the happening of several events that are independent on each other, the value of the expectation of that sum is found by multiplying together the several probabilities of happening, and by multiplying the product by the value of the sum expected. E. gr. Suppose, that in order to obtain 90*l.* two events must happen, one of which has three chances to happen and two to fail, and the other has four chances to happen, and five to fail; the value of the expectation is  $= \frac{3}{5} \times \frac{4}{9} \times 90 = \frac{12}{45} \times 90 = 24*l.*$  for if the first event had actually happened, the value of the expectation depending solely on the second event, would be  $\frac{4}{9} \times 90 = 40*l.*$  and therefore the happening of the first event is the condition of obtaining an expectation worth 40*l.* but the probability of the first happening is  $\frac{3}{5}$ , and the expectation sought for is evidently worth  $\frac{3}{5} \times 40 = \frac{3}{5} \times \frac{4}{9} \times 90 = 24*l.*$  The rule will be the same if an expectation depends on the happening of one event and the failing of another; and also on the failing of two events; and on the happening or failing of any number of events that may be assigned. It is here supposed that the events are independent, or that the happening of one, neither forwards nor obstructs the happening of the other. But if two events are dependent, i. e. if they are so connected together as that the probability of either's happening is altered by the happening of the other, the probability of their happening is the product of the probability of the happening of one of them by the probability which the other will have of happening, when the first is considered as having happened; and the same rule will extend to the happening of any assigned number of events: thus, in a heap of thirteen cards of the same colour, the probability of taking out the ace is  $\frac{1}{13}$ ; and the probability of taking the ace out of another heap of the same number is  $\frac{1}{13}$ ; and the probability of both these independent events happening will be  $\frac{1}{13} \times \frac{1}{13} = \frac{1}{169}$ : but the probability of taking the ace first out of a single heap of thirteen cards is  $\frac{1}{13}$ ; and that of taking the deuce afterwards is  $\frac{1}{12}$ ; and therefore the probability of both happening is  $\frac{1}{13} \times \frac{1}{12} = \frac{1}{156}$ . If a person has several expectations on several sums, the value of his expectation on the whole is the sum of his expectations on the particulars: thus, let one event be such, that the probability of obtaining any sum, e. gr. 90*l.* in case it happens, may be  $\frac{3}{5}$ ; in which case the value of the expectation is  $\frac{3}{5} \times 90 = 54*l.*$  Let the probability of another event, on which depends a second sum of 90*l.* be  $\frac{4}{9}$ , and the value of the expectation in this case be  $\frac{4}{9} \times 90 = 40*l.*$  and the value of the expectation on the whole  $54 + 40 = 94*l.*$  But if a person is to receive 90*l.* once for all for the happening of one or other of the two forementioned events, then the expectation of the first event being worth 54*l.* as before, yet the expectation of the second will be different; because this depends on the happening of the first, and takes place only in case the first happens to fail, the probability of which is  $\frac{2}{5}$ ; and

# EXPECTATION.

on the supposition of its having failed, the expectation of the second will be 40%; therefore  $\frac{2}{3}$  is the measure of the probability of obtaining an expectation worth 40%; and consequently the expectation will be worth  $\frac{2}{3} \times 40 = 16\frac{2}{3}$  and the value of the expectation on the whole will be  $54 + 16\frac{2}{3} = 70\frac{2}{3}$ . See the farther illustration and application of these principles and rules in De Moivre's *Doctrinae of Chances*, edit. 3. 1776. See CHANCES and GAMING.

EXPECTATION of Life, in the *Doctrinae of Life Annuities*, denotes, according to the most obvious sense of the term, that particular number of years which a life of a given age has an equal chance of enjoying, or the time which a person of a given age may justly expect to continue in being. But Mr. Simpson has shewn, that this period does not coincide with what the writers on annuities call the expectation of life, except on the supposition of an uniform decrease in the probabilities of life; and Dr. Price adds, that even on this supposition, it does not coincide with what is called the expectation of life, in any case of joint lives: for two lives of 40 have an even chance, according to Mr. De Moivre's hypothesis (see *COMPLEMENT of life*) of continuing together only  $13\frac{1}{2}$  years. According to that hypothesis, the probability that a life aged 40 will continue  $13\frac{1}{2}$  years will be expressed by  $\frac{32.5}{46}$ ; and this fraction multiplied by itself is the probability that two lives of this age shall both continue  $13\frac{1}{2}$  years; i.e.  $\frac{32.5}{46} \times \frac{32.5}{46} = \frac{1056.25}{2116}$ , equal nearly  $\frac{1}{2}$ , which represents an even chance; but the expectation of two joint lives being (according to the same hypothesis) always a third of the common complement, will be in this case  $15\frac{1}{3}$  years. Therefore, the expectation of life may signify the mean continuance of any given single, joint, or surviving lives, according to any given table of observations, or the number of years which, taking them one with another, they actually enjoy; so that if 46 persons are alive, all 40 years of age, and one be supposed to die every year, according to Mr. De Moivre's hypothesis, till they are all dead in 46 years, half 46 or 23 will be their expectation of life; i.e. the number of years enjoyed by them all will be the same as if every one of them had lived 23 years, and then died; and supposing no interest of money, the value of an annuity payable for life to every single person in such a set, would just be equal to 23 years purchase.

The expectation of life coincides with the sums of the present probabilities, that any given single or joint lives shall attain to the end of the first, second, third, &c. moments, from this time to the end of their possible existence; or (in the case of survivorships) with the sum of the probabilities, that there shall be a survivor at the end of the first, second, third, &c. moments, from the present time to the end of the possible existence of survivorship. From these principles Dr. Price has shewn how to deduce the demonstrations of Mr. De Moivre's rules for finding the expectations of lives, which he has omitted; we shall here subjoin them for the information and amusement of our mathematical readers. Let  $\dot{x}$  stand for a moment of time, and  $n$  be the complement of any assigned life; then  $\frac{n-\dot{x}}{n}$ ,  $\frac{n-2\dot{x}}{n}$ ,  $\frac{n-3\dot{x}}{n}$ , &c. will be the present probabilities of its continuing to the end of the first, second, third, &c. moments; and  $\frac{n-x}{n}$  the probability of its continuing to the end of  $x$  time: therefore,  $\frac{n-x}{n} \times \dot{x}$  will be the fluxion of the sum of the probabilities, or of an area representing this sum, whose ordinates are

$\frac{n-x}{n}$ , and axis  $x$ . The fluent of this expression, or  $x - \frac{x^2}{2n}$ , is the sum itself for the time  $x$ ; and this, when  $x = n$ , becomes  $\frac{1}{2}n$ , the expectation of the assigned life, or the sum of all the probabilities just mentioned for its whole possible duration. In like manner  $\frac{n-x}{n} \times \frac{n-x}{n}$  or  $\frac{(n-x)^2}{n^2}$  is the probability that two equal joint lives will continue  $x$  time, and  $\frac{(n-x)^2}{n^2} \times \dot{x}$  will be the fluxion of the sum of the probabilities; the fluent of which, or  $x - \frac{x^2}{n} + \frac{x^3}{3n^2}$ , becomes, when  $x = \frac{n}{3}$ , or the expectation of two equal joint lives. Again, since  $\frac{n-x}{n} \times \frac{2x}{n}$  is the probability that there will be a survivor of two equal joint lives at the end of  $x$  time,  $\frac{n-x}{n} \times \frac{2x}{n} \times \dot{x}$  will be the fluxion of the sum of the probabilities; and the fluent, or  $\frac{x^2}{n} - \frac{2x^3}{3n^2}$ , is, when  $x = n, \frac{2}{3}n$ , or the expectation of survivorship between two equal lives, which appears to be equal to the expectation of their joint continuance. The expectation of two unequal joint lives found in the same way is  $\frac{m}{2} - \frac{m^2}{6n}$ ,  $m$  being the complement of the oldest life, and  $n$  the complement of the youngest. The whole expectation of survivorship is  $\frac{n}{2} - \frac{m}{2} + \frac{m^2}{3n}$ ; and the expectation of survivorship of the oldest will be to that of the youngest as  $\frac{m^2}{6n}$  to  $\frac{n}{2} - \frac{m}{2} + \frac{m^2}{6n}$ .

From the definition already given of the expectation of life, it follows, that if in a society limited to a fixed number of members, a 28th part of its members dies annually, 28 would appear to be their common expectation of life at the time they entered; and if it were found in any town or district, where the number of births and burials are equal, that a 20th or 30th part of the inhabitants die annually, it would appear that 20 or 30 was the expectation of a child just born in that town or district.

Having a table of observations, shewing the number that die annually at all ages out of a given number alive at those ages, it is easy to find the expectation for all single lives by the following rule: divide the sum of all the living in the table at the age whose expectation is required, and at all greater ages, by the number in the table of the living at that age, and subtract half unity from the quotient, the remainder will be the expectation required.

The reason of this subtraction may be understood by conceiving the recruit necessary to supply the waste of every year to be made always at the end of the year, so that the dividend ought to be the medium between the number living at the beginning and the end of the year; that is, it should be taken less than the sum of the living in the table at and above the given age by half the number that die in the year; the effect of which diminution will be the same with the subtraction here directed. This rule may be illustrated by taking the sum of all the living at 20 and upwards in Tab. I. and dividing it by 360, the number living at that age, and the quotient less half unity, will be nearly 28.9 the expectation of 20 in Tab. II.

# EXPECTATION.

TABLE I.—Shewing the Probability of the Duration of Life in London, deduced by Mr. Simpson from Observations on the Bills of Mortality in London for 10 Years, from 1723 to 1737.

Age	Perfons living.	Decr. of life.	Age	Perfons living.	Decr. of life.	Age	Perfons living.	Decr. of life.
0	1000	320	27	321	6	54	135	6
1	680	133	28	315	7	55	129	6
2	547	51	29	308	7	56	123	6
3	496	27	30	301	7	57	117	5
4	469	17	31	294	7	58	112	5
5	452	12	32	287	7	59	107	5
6	440	10	33	280	7	60	102	5
7	430	8	34	273	7	61	97	5
8	422	7	35	269	7	62	92	5
9	415	5	36	259	7	63	87	5
10	410	5	37	252	7	64	82	5
11	405	5	38	245	8	65	77	5
12	400	5	39	237	8	66	72	5
13	395	5	40	229	7	67	67	5
14	390	5	41	222	8	68	62	4
15	385	5	42	214	8	69	58	4
16	380	5	43	206	7	70	54	4
17	375	5	44	199	7	71	50	4
18	370	5	45	192	7	72	46	4
19	365	5	46	185	7	73	42	3
20	360	5	47	178	7	74	39	3
21	355	5	48	171	6	75	36	3
22	350	5	49	165	6	76	33	3
23	345	6	50	159	6	77	30	3
24	339	6	51	153	6	78	27	2
25	333	6	52	147	6	79	25	
26	327	6	53	141	6			

TABLE II.—Shewing the Expectations of Life in London, according to the preceding Table.

Age.	Expectation.	Age.	Expectation.	Age.	Expectation.
0	19.2	27	25.1	54	14.5
1	27.0	28	24.6	55	14.2
2	32.0	29	24.1	56	13.8
3	34.0	30	23.6	57	13.4
4	35.6	31	23.1	58	13.1
5	36.0	32	22.7	59	12.7
6	36.0	33	22.3	60	12.4
7	35.8	34	21.9	61	12.0
8	35.6	35	21.5	62	11.6
9	35.2	36	21.1	63	11.2
10	34.8	37	20.7	64	10.8
11	34.3	38	20.3	65	10.5
12	33.7	39	19.9	66	10.1
13	33.1	40	19.6	67	9.8
14	32.5	41	19.2	68	9.4
15	31.9	42	18.8	69	9.1
16	31.3	43	18.5	70	8.8
17	30.7	44	18.1	71	8.4
18	30.1	45	17.8	72	8.2
19	29.5	46	17.4	73	7.8
20	28.9	47	17.0	74	7.5
21	28.3	48	16.7	75	7.2
22	27.7	49	16.3	76	6.8
23	27.2	50	16.0	77	6.4
24	26.6	51	15.6	78	6.0
25	26.1	52	15.2	79	5.5
26	25.6	53	14.9	80	5.0

TABLE III.—Shewing the Probabilities of Human Life in Northampton.

Age	Living.	Decr.	Age	Living.	Decr.	Age	Living.	Decr.
0	11650	1340	31	4310	75	65	1632	80
3 mon.	10310	554	32	4235	75	66	1552	80
6 mon.	9756	553	33	4160	75	67	1472	80
9 mon.	9203	553	34	4085	75	68	1392	80
1 Year	8650	1367	35	4010	75	69	1312	80
2 Years	7283	502	36	3935	75	70	1232	80
3	6781	335	37	3860	75	71	1152	80
4	6446	197	38	3785	75	72	1072	80
5	6249	184	39	3710	75	73	992	80
6	6065	140	40	3635	76	74	912	80
7	5925	110	41	3559	77	75	832	80
8	5815	80	42	3482	78	76	752	77
9	5735	60	43	3404	78	77	675	73
10	5675	52	44	3326	78	78	602	68
11	5623	50	45	3248	78	79	534	65
12	5573	50	46	3170	78	80	469	63
13	5523	50	47	3092	78	81	406	60
14	5473	50	48	3014	78	82	346	57
15	5423	50	49	2936	79	83	289	55
16	5373	53	50	2857	81	84	234	48
17	5320	58	51	2776	82	85	186	41
18	5262	63	52	2694	82	86	145	34
19	5199	67	53	2612	82	87	111	28
20	5132	72	54	2530	82	88	83	21
21	5060	75	55	2448	82	89	62	16
22	4985	75	56	2366	82	90	46	12
23	4910	75	57	2284	82	91	34	10
24	4835	75	58	2202	82	92	24	8
25	4760	75	59	2120	82	93	16	7
26	4685	75	60	2038	82	94	9	5
27	4610	75	61	1956	82	95	4	3
28	4535	75	62	1874	81	96	1	1
29	4460	75	63	1793	81			
30	4385	75	64	1712	80			
						Tot.	299198	11650

TABLE IV.—Shewing the Expectations of Human Life, deduced from the preceding Table.

Age.	Expect.	Age.	Expect.	Age.	Expect.	Age.	Expect.
0	25.18	25	30.85	50	17.99	75	6.54
1	32.74	26	30.33	51	17.50	76	6.18
2	37.79	27	29.82	52	17.02	77	5.83
3	39.55	28	29.30	53	16.54	78	5.48
4	40.58	29	28.79	54	16.06	79	5.11
5	40.84	30	28.27	55	15.58	80	4.75
6	41.07	31	27.76	56	15.10	81	4.41
7	41.03	32	27.24	57	14.63	82	4.09
8	40.79	33	26.72	58	14.15	83	3.80
9	40.36	34	26.20	59	13.68	84	3.5
10	39.78	35	25.68	60	13.21	85	3.37
11	39.14	36	25.16	61	12.75	86	3.19
12	38.49	37	24.64	62	12.28	87	3.01
13	37.83	38	24.12	63	11.81	88	2.86
14	37.17	39	23.60	64	11.35	89	2.66
15	36.5	40	23.08	65	10.88	90	2.41
16	35.85	41	22.56	66	10.42	91	2.09
17	35.20	42	22.04	67	9.96	92	1.75
18	34.58	43	21.54	68	9.50	93	1.37
19	33.99	44	21.03	69	9.05	94	1.05
20	33.43	45	20.52	70	8.60	95	0.75
21	32.90	46	20.02	71	8.17	96	0.50
22	32.39	47	19.51	72	7.74		
23	31.88	48	19.00	73	7.33		
24	31.36	49	18.49	74	6.92		

We shall here subjoin some other tables, calculated by Dr. Price, on account of their connection with the subject of this article.

Proportion of the inhabitants annually dying in

Pais De Vaud	Country Parish in Brandenburg	Holy Crofs near Shrewsbury	London	Vienna	Berlin.
1 in 45	1 in 45	1 in 33	1 in 20 $\frac{1}{2}$	1 in 19 $\frac{1}{2}$	1 in 26 $\frac{1}{2}$

Ages to which half the born live.

Pais De Vaud	Country Parish in Brandenburg	Holy Crofs	London	Vienna	Berlin.
41	25 $\frac{1}{2}$	27	2 $\frac{3}{4}$	2	2 $\frac{3}{4}$

Proportion of the inhabitants who reach eighty years of age.

Pais De Vaud	Country Parish in Brandenburg	Holy Crofs	London	Vienna	Berlin.
1 in 21 $\frac{1}{2}$	1 in 22 $\frac{1}{2}$	1 in 11	1 in 40	1 in 41	1 in 37

The probabilities of living one year in

Olds	Pais De Vaud	Country Parish in Brandenburg	Holy Crofs	London	Vienna	Berlin.
At birth	4 $\frac{1}{4}$ to 1	3 $\frac{1}{2}$ to 1	4 $\frac{1}{2}$ to 1	2 to 1	1 $\frac{1}{5}$ to 1	1 $\frac{1}{4}$ to 1
Age 12	160	112	144	175	184	123
25	117	110	100	156	166	150
30	111	107	96	145	156	144
40	83	78	55	131	136	132
50	49	50	50	124	127	130
60	23	25	26	118	119	118
70	9 $\frac{1}{2}$	11	16	112	111	112
80	4	6	8	7	7	7

Expectations of life.

	Pais De Vaud	Country Parish in Brandenburg	Holy Crofs	London	Vienna	Berlin.
At birth	57 y <sup>r</sup>	32 $\frac{1}{2}$ years	33 $\frac{1}{4}$ y <sup>r</sup>	18 y <sup>r</sup>	16 $\frac{1}{2}$ y <sup>r</sup>	18 y <sup>r</sup>
Age 12	44 $\frac{1}{2}$	44 $\frac{1}{2}$	43 $\frac{1}{2}$	33 $\frac{1}{2}$	35 $\frac{3}{4}$	35 $\frac{1}{2}$
25	34 $\frac{3}{4}$	35 $\frac{1}{2}$	35	26	28 $\frac{1}{2}$	27 $\frac{1}{4}$
30	31 $\frac{1}{4}$	31 $\frac{1}{2}$	32	23 $\frac{1}{2}$	25 $\frac{1}{2}$	25 $\frac{1}{4}$
35	27 $\frac{1}{2}$	28	28 $\frac{1}{2}$	21 $\frac{1}{2}$	22 $\frac{1}{2}$	22 $\frac{3}{4}$
40	24	25	25 $\frac{1}{4}$	19 $\frac{1}{2}$	20 $\frac{1}{2}$	20 $\frac{3}{4}$
45	20 $\frac{1}{2}$	21 $\frac{1}{2}$	23 $\frac{1}{4}$	17 $\frac{3}{4}$	17 $\frac{3}{4}$	18 $\frac{3}{4}$
50	17 $\frac{1}{2}$	18	20	16	16	16 $\frac{1}{2}$
55	14 $\frac{1}{2}$	15	17	14 $\frac{1}{2}$	13 $\frac{1}{2}$	14
60	12	12 $\frac{1}{4}$	14 $\frac{1}{4}$	12 $\frac{1}{2}$	11 $\frac{1}{4}$	12 $\frac{1}{2}$
65	9 $\frac{1}{2}$	9 $\frac{3}{4}$	11 $\frac{1}{4}$	10 $\frac{1}{2}$	9 $\frac{3}{4}$	10 $\frac{1}{2}$
70	7 $\frac{1}{2}$	7 $\frac{1}{2}$	10	8 $\frac{1}{4}$	8 $\frac{1}{2}$	8 $\frac{1}{2}$
75	5 $\frac{1}{2}$	5 $\frac{1}{2}$	8	7	6 $\frac{1}{2}$	7
80	4 $\frac{1}{2}$	4 $\frac{1}{2}$	5	5	5 $\frac{1}{2}$	6

Dr. Price has applied his reasoning on this subject to the solution of a curious question in political arithmetic, or to determine the number of inhabitants in any place from a table of observations, or the bills of mortality for that place, on the supposition that the yearly births and burials are equal. For this purpose find by the table the expecta-

tion of an infant just born; and this, multiplied by the number of yearly births, will be the number of inhabitants

Were the bills of mortality constructed with the least regard to truth, and were a regular account kept of all the persons who annually migrate from the country, this rule of Dr. Price might be safely applied towards ascertaining the number of inhabitants in London, but in their present form the London tables are so very incorrect that it can hardly be safe to derive any conclusions from them.

It appears from Tab. I. that though an infant just born in London has not an equal chance (the probability being  $\frac{1000}{10000}$ ) of living three years, his expectation is twenty years, and by Tab. III. that though the expectation of such a child in Northampton is twenty-five, it has only an equal chance of living eight years. This difference proceeds from the greater probability of life in the more mature ages, than in the first moments of existence. Were the decrements of life, however, the same through every period of it, these quantities would always be equal; but as this is not the case, neither in the earlier nor the latter ages, the computations founded on such an hypothesis can in general be of very little use. De Moivre's Doctrine of Chances; applied to the Valuation of Annuities, p. 288, &c. Simpson's Select Exercises, p. 253, &c. and particularly Dr. Price's Observations on Reversionary Payments, eff. i. vol. ii. or Phil. Trans. vol. lix. p. 89. See COMPLEMENT of Life, LIFE ANNUITIES, MORTALITY, SURVIVORSHIP.

EXPECTATIVE, in the Canon Law, a hope founded on a promise of obtaining the next benefice that shall become vacant, or a right to the reversion of the next. See BENEFICE.

EXPECTATIVE Canons. See CANON.

EXPECTATIVE Graces, *Gratie Expectativa*, called also *preventions*, were bulls frequently given by the popes or kings for future benefices. The bishops were exceedingly mortified with them, because they encroached on their privileges; besides, that such expectatives are odious, as they induce people to wish for the death of others.

The use of expectatives is very ancient, though it was not near so frequent in the first ages as afterwards. Originally they were no more than simple requests made on the part of kings or popes, which the bishops consented to with the more willingness, as they only presented to them persons fit to serve the church; but the frequent exercise of this privilege made it at length be deemed a matter of obligation and necessity.

The council of Trent annulled all expectatives; but the canons relating thereto were never admitted in France, where the right of conferring expectative graces is looked on as one of the regalia.

EXPECTORANT MEDICINES, are those which facilitate the excretion of the mucous discharges from the cells and passages of the lungs; or *expellere*, from the breast.

This evacuation must be accomplished by more or less of coughing, which the irritation of the collecting mucus, &c. naturally occasions. It were, therefore, obviously useless and superfluous to give medicines with a view to excite coughing, (if indeed we were acquainted with any substance possessed of such quality,) or to use any external means, as the ancient Cnidians are said to have done, for that purpose. The principal object, in attempting to facilitate the discharge of the contents of the bronchial vessels and cells, must consist in changing the nature of those contents, so as to render them thinner, less tenacious, and more moveable than before. Whether we are possessed of any medicines, however, capable of producing such a direct effect, may admit

mit of a question. The generality of writers on the materia medica, and of physicians, speak of the utility of such medicines as they have termed *attenuantia* and *incidentia*, for this purpose: but we believe, with Dr. Cullen, that their hypothesis on this subject is altogether erroneous, and that no such medicines exist. The only probable explanation of the action of an expectorant medicine appears to be, that by increasing the secretion from the exhalent arteries in the lungs, the mucus may be diluted and rendered less viscid and the passages from the cells may be more fully moistened with a less tenacious fluid. We know that there is a constant and considerable exhalation of moisture from the cavity of the lungs; and there are many reasons for believing that this is an excrementitious secretion, connected with the other excrementitious secretions, particularly with the perspiration from the surface of the body. If, therefore, there are medicines disposed to pass by perspiration, it may be presumed that the same are disposed to pass by the exhalation from the lungs: and this exhalation may not only be increased, but the mucus, produced by the follicles, may also be poured out in a less viscid form, and consequently in a state to be more easily brought up by expectoration.

It would appear, that some such increase of the thinner secretion of lungs is produced, by sympathy with the stomach, when a condition approaching to nausea is induced, and that, therefore, medicines which possess an emetic quality, when used in small doses, operate in some degree as expectorants; such as the squill, ipecacuanha, nicotiana, antimony, &c. A full dose of an emetic seems to produce this effect more completely, and affords considerable relief to those asthmatic complaints, as they are called, in which the lungs are loaded with a quantity of viscid phlegm. Many expectorant medicines are mentioned by different writers, such as the tussilago, or colt's foot, enula campana, iris florentina, petasites, &c. which recent experience seems to have rejected, from their failure to answer the expectation which those writers had excited.

Many other medicines which give relief to coughs have been employed under the appellation of expectorants; but their operation is to be explained upon principles altogether different from that of facilitating expectoration. Among these are spermaceti, liquorice, oil of almonds, and other vegetable and animal oils, various mucilaginous vegetables, such as mallow, horehound, &c. all of which give a temporary alleviation to the irritation about the glottis, and thus appease the cough, but do not in the smallest degree aid the expectoration. See CATARRH.

In the chronic coughs of old people, expectoration appears to be facilitated by the use of the stimulant gums, and of volatile alkali. But perhaps these medicines operate indirectly, by supporting the strength of the patients, and thus enabling them to use greater muscular exertion in the act of coughing.

EXPECTORATION, the act of bringing up the mucous and other excretions from the lungs, by coughing, hawking, &c. The word has the same derivation as the preceding.

EXPEDITATION, in the *Forest-Laws*, signifies a cutting out the balls of a dog's fore-feet for the preservation of the king's game.

Every one that keeps any great dog, not expeditated, forfeits three shillings and four-pence to the king. In mastiffs, not the ball of the feet, but the three claws, are to be cut to the skin. Instit. part. iv. p. 308. "Nullos Dominicos canes abbatis & monachorum expeditari cogat." Chart.

Hen. III. "Et sin quieti de expeditamentis canum." Ex. Mag. Rot. Pip. de ann. 9 Ed. II.

The expeditation was to be performed once in every three years, and was done to every man's dog who lived near the forest, and even the dogs of the foresters themselves.

EXPEDITION, the march of an army to some distant place, with a view of hostilities.

Such were the expeditions of Cyrus against Xerxes, and of Bacchus and Alexander to the Indies.

Expeditions for the recovery of the Holy Land were called croisades.

The success of an expedition depends on rapid and unexpected movements. An expedition is planned and governed by the following principal maxims, viz. secrecy, if possible, of preparation, and a concealment of design, &c.; a just proportion of the means to the end; a knowledge of the state and situation of the country, which is intended to be the scene of action, and of the place or object that is to be attacked; the appointment of a commander, possessed of those abilities, and of that disposition, which are adapted to the warfare proposed; and the arrangement of the plan of the expedition before it is undertaken or carried into effect. The French use the word expedition to express any particular military quality, which an officer or soldier may possess. Thus, "cet officier est un homme d'expedition," that is, this officer is a man of enterprise, or courageous and daring.

EXPENCES, in *Book-keeping*. See *Book of Expences*.

EXPENDITORS, in *Law*, are the persons appointed by commissioners of sewers, to pay, disburse, or expend the money collected by the tax for the repairs of sewers, &c. when paid into their hands by the collectors on the reparations, amendments, and reformations ordered by the commissioners; for which they are to render accounts when required for that purpose.

These officers are mentioned in the statute 37 H. VIII. cap. 11. and other statutes. The steward who supervises the repair of the banks and water-courses in Romney Marsh is likewise called the expeditor.

EXPENSE MAGAZINE, is a small receptacle for such quantities of ammunition as may be required on emergency, or for the supply of powder, &c. in that ordinary course which enables the proper officers to estimate with correctness what quantity should be kept at hand for the purpose of annual exercise, or for the furnishing the neighbouring camps, posts, or batteries, with such stores as may be necessary for their use. Thus we see, in almost every fortress, various expense-magazines built in commodious and safe situations, for the express purposes of enabling the commissaries, and the ordnance officers, to prevent the defenders of the several works in their vicinity from being at a stand for want of ammunition. Some of these little stores are occasionally built even upon the terre-pleine of the batteries they are to supply; but we have heard this practice censured; for, though it may be true, that owing to their very solid construction they may successfully resist the enemies' shot, still, as they are liable to explode from other accidents, we cannot join an unqualified approval of such positions. We avail ourselves of a suggestion offered to us, in which we think the foregoing objection is greatly diminished, if not totally removed. The suggestion is, that in lieu of allowing any expense-magazines to be built on a terre-pleine, a ramp should be thrown up at the back of every sixth or seventh piece of ordnance on the defences, the interior of which should be a magazine of this description. The ramp would serve as a passage for the persons employed in conveying the powder to the gunners, and should have a door at that side

least exposed to enfilades, or to accidental shots. The entrance might, indeed, be either above or below the ramp; though we are disposed to recommend the latter; as the delay occasioned by ascending would not be of any consequence in ordinary defences, and would be fully counter-balanced by the safety with which all the expense-magazines might be worked. Possibly, the suggestion might be rather improved if the expense-magazines were to be built partly under the respective ramparts; thereby becoming mines on occasion. (See *Plate I. Tactics, fig. 4.*)

Against works of masonry built upon the terre-pleine, we cannot too powerfully inveigh: the immense numbers of splinters which are generally created by such being sufficient grounds for their condemnation. If, however, it is deemed proper to have small magazines in such situations, (for there may be localities which afford no alternative,) such ought to be sunk so far as to allow the summits of their arches to be little more than level with the terre-pleine. Being then covered with soil, and well gazoned, (*i. e.* turfed,) they would become useful, by causing such shots as might be sent over the epaulement to throw up, instead of allowing them to trundle along the terre-pleine. (See *ENFILADE.*)

The entrances of all magazines of this description ought to be towards the back of the battery, and certainly might be rendered safer by making a few steps down upon the inner revetement; so as completely to cover not only the magazine itself; but the persons who might be employed to hand up the cartridges. (See *fig. 5.*)

*EXPENSIS Militum Levandis*, in *Law*, was a writ anciently directed to the sheriff, for levying allowance for the knights of parliament. See *PARLIAMENT*, and *REPRESENTATIVE*.

*EXPENSIS militum non levandis*, &c. an ancient writ to prohibit the sheriff from levying any allowance for knights of the shire upon those that hold lands in ancient demesne. *Reg. Orig.* 261.

*EXPERIENCE*, a kind of knowledge acquired by long use without any teacher.

Experience consists in the ideas of things we have seen or read, which the judgment has reflected on, to form for itself a rule or method.

Authors make three kinds of experience: the first is the simple uses of the external senses, whereby we perceive the phenomena of natural things, without any direct attention thereto, or making any application thereof.

The second is, when we premeditatedly and designedly make trials of various things, or observe those done by others, attending closely to all effects and circumstances.

The third is that preceded by a fore-knowledge, or at least an apprehension of the event, and determines whether the apprehension were true or false; which two latter kinds, especially the third, are of great service in philosophy.

Dr. Campbell, in his "Philosophy of Rhetoric," (vol. i. p. 129, &c.) investigates the nature and origin of experience; and observes, that those sources in our natures which give being to it, and consequently to all those attainments, moral and intellectual, that are derived from it, are sense and memory. The senses, both external and internal, are the original inlets of perception; and the articles of information exhibited by them are devolved on the memory. As remembrance instantly succeeds sensation, the memory becomes the sole repository of the knowledge received from sense; and hence it is the only original voucher extant of those past realities for which we had once the evidence of sense.

In order to render the knowledge thus acquired and preserved useful to us, in discovering the nature of things and regulating our conduct, a further process of the mind is necessary, and this is association. This retention and association are called experience. We may here observe, that though memory gives birth to experience, which results from the comparison of facts remembered, the experience, or habitual association, remains, when the individual facts on which it is founded are all forgotten. We cannot pursue the reasoning of this ingenious writer in his illustration of the evidence of experience, which he considers as one species of moral evidence, (analogy and testimony being the two others,) and which, in his opinion, is the criterion, if not the foundation, of all moral reasoning whatever, and the principal organ of truth in all the branches of physiology, in the largest acceptation of the term. See *TESTIMONY*.

*EXPERIMENT*, from the Latin *experimentum*, is a trial, or practical proof of something. In philosophy it means the result of certain applications, dispositions, or combinations, of natural bodies, made with some particular view. Experiments are said to be mechanical, or chemical, or electrical, or magnetical, &c. according to the subject to which they more immediately belong. The object of making experiments is to ascertain either certain causes or certain phenomena; and for the proper attainment of these objects care must be had to institute experiments that admit of no equivocal result, and so as to answer the purpose in the quickest and most direct way. The main object, however, of the inquiry can seldom be determined by a single decisive experiment; hence, in most cases, it becomes necessary to divide the question into parts, and to ascertain each part separately by one or more appropriate experiments. When the experiment is so prescribed as to decide the question without any possible doubt or equivocation, it has in that case frequently been called *experimentum crucis*; meaning a capital or decisive experiment; such as supercedes the necessity of instituting more experiments for the same purpose. The origin of the expression *experimentum crucis* has probably been derived from its being a kind of torture, whereby the nature of the question is, as it were, extorted by force. It has been also attributed, though with less apparent probability, to the guide or instruction which it affords, like that of a direction post, which is shaped somewhat like a cross.

It is not practicable to give any instructions for the right performance of experiments in general; for not only every subject, but every particular question belonging to any subject, must be determined by a peculiar mode of investigation. The experimenter can only be instructed by practice. The nature of the subject, a strict attention to every apparent circumstance, an accurate statement of particulars, and an unprejudiced mode of reasoning, will easily suggest a proper train of experiments which the subject in question may admit of. It deserves to be remarked, that though in the investigation of any subject, the philosopher proposes a certain order of investigation, (and it is always proper to propose to oneself some such plan or train of experiments;) yet it is but seldom that the proposed plan can, or deserves to be strictly executed; for the result of the first or second experiment frequently points out a new track or a more promising road; in consequence of which, new and different trials must be instituted; and it is in the ready adoption of such plans as may be more suited to the last indications, that the genius of the philosopher is rendered conspicuous.

Such mode may suffice for the determination of any doubtful point; but when a discovery has been made and is to be explained

explained to other persons; then it is of use to shew the same result by different experiments; for it is not only a satisfaction to have several concurring proofs of the same proposition; but it is also rendered intelligible to a greater number of readers or hearers; it being seldom the case, that the same experiment conveys an equal degree of conviction and satisfaction to the mind of every body.

EXPERIMENTAL FARM, in *Agriculture*, that sort of farm establishment which is chiefly applied to, or calculated for, the purpose of making experiments, with the view of ascertaining unknown causes, effects, or results in the various departments of husbandry. This is a plan which has often been attempted, both individually and collectively, by numbers of persons warmly interested in promoting the improvement of agricultural knowledge; but hitherto, we believe, without that sort of success which might naturally be expected. The cause of which has probably been the want of a due combination of real practical agricultural information with that of the scientific kind, as without a full comprehension of both these, in persons who have the direction and management of such establishments, it must be utterly impossible that they can be so highly advantageous as they ought to be. But a writer, who has bestowed much attention on the subject, seems to suppose that, there is much doubt of any real benefit being at all produced in this way; as he considers both experience and experiment the two means by which facts concerning the art may be ascertained as equally liable to objection. The term *experience* he conceives to denote those deductions which a person draws as the average result of practice continued for a considerable length of time, and which is unquestionably the surest guide that can be followed, where the observations are sufficiently correct, and the circumstances discriminated in so clear a manner as to create no sort of confusion; still where these peculiarities are wanting, the conclusions thus drawn may be extremely fallacious. And what increases the evil in this case is, that when conclusions have been once drawn in consequence of an imperfect discrimination of circumstances, there is scarcely any chance of eradicating the error; as the mind, when once accustomed to think in a certain way, is apt to proceed in the same ever afterwards; and that the same indiscrimination which caused the first error will induce a succession of others of the same sort *ad infinitum*. Unfortunately, too, it happens that in agriculture, things which are capable of affecting the result of a process or operation, are so jumbled and thrown together into one chaotic mass, that it is a matter of extreme difficulty even for the most nice observer to distinguish such as are essential, from those which are merely accidental, consequently extremely easy to mistake one for the other. The inaccuracy likewise, which too much prevails in the operations of the farmer, concerning the actual expence of different processes, as affecting any particular object; and all the difficulty of keeping the different produce of different fields separate, render it, in most cases, almost impossible for the actual farmer to ascertain, with any sort of precision, either the expence or the value of the produce of any one of his fields; consequently the profit or loss of any operation or process is merely guessed at, not ascertained by the test of his experience; in consequence of which he is at liberty, and will of course draw the conclusion, which seems most to confirm his own pre-conceived notion on the head, whatever it may be. Under such circumstances experience must, he conceives, be a very fallacious and imperfect guide. It may, indeed, it is supposed, furnish hints or indications of what ought to be pursued or laid aside and avoided; but that un-

less facts be ascertained with much greater precision than it admits of, they must, it is conceived, afford a very unstable foundation for promoting the scientific improvement of agriculture.

In consequence of which, experiment, he thinks, has been introduced and adapted, in order to supply the deficiencies which are thus produced; but which, though, at the first sight, it may promise fair to accomplish such purposes, upon a nearer view has not been found adequate in any material degree. An experiment in this art is, it is conceived, a particular operation, undertaken with the design of elucidating and explaining some fact which is involved in doubt or difficulty; of course extreme accuracy, in order to guard against every circumstance that may unintentionally affect or influence the result, is an indispensable requisite in the conducting of it; as, unless this be the case, the same experiment, under different circumstances, may lead to a variety of conclusions. In general, however, farmers, from their having been but little accustomed to the nice discriminations of scientific investigation, are but indifferently qualified to guard against the secret influence of causes, which they have never even so much as suspected of having any power upon the result of their experiment. It is, therefore, contended, that from these causes the experiments made by actual farmers frequently prove extremely defective; and when amateurs of a higher rank project experiments, the detail of them must be left to servants and dependants, who commonly put down at random all the circumstances which their carelessness prevented them from noticing; so that these experiments, though they may assume a more engaging appearance of accuracy, are, in fact, for the most part, more inaccurate and erroneous than the former. Consequently, with the view of remedying these evils, the notion of an experimental farm has presented itself to many persons as the only means of forwarding the progress of scientific agriculture, and upon a slight view, the benefits that might result from it have indeed seemed so obvious, that in several districts of this country funds have been provided, as has been already hinted, for the support of such establishments, but on trial they have all found such difficulties in the way, as have not hitherto been capable of being surmounted. The chief reason of which, it is conceived, is, as has been suggested before, that of the difficulty of procuring a person in every way properly qualified for conducting such an undertaking. On these grounds, the expectations of the benefits that are to be derived from the establishment of an experimental farm are not by any means so great as may be supposed. It is, indeed, contended, that there are many experiments of the very first importance in scientific agriculture, which are totally out of, or beyond the sphere of a farm of this kind. Of this description, it is conceived, are all those facts which have a relation to the original constitution of soils, and the infinitely diversified, though little obvious qualities these possess in consequence of peculiar impregnations, which they may have derived from the operations of nature or of art. It is supposed that an experimental farm, in so far as this particular is concerned, is precisely the same as another farm, in which the experimenter, like the farmer, may in time acquire a knowledge of what will suit his own soil. But if these experiments were presented to the public under the idea that the results which they afforded should be deemed generally conclusive in all districts, such a decision would turn out fallacious, as it would soon be found, that, in many other cases, the results would be extremely different. Nor is it believed that the practical farmer could derive much advantage from the experimental farm, in what respects the

## EXPERIMENTAL.

economical distribution or arrangement of the necessary business which is to be pursued in the conducting of the work, which is a branch of the art that is of the greatest consequence to be well understood by the real farmer, but that is totally incompatible with the complex arrangements and continually varying operations of the experimental farm.

But however true many of these remarks may be, there can be little doubt, but that the establishment of experimental farms in different parts of the country must, under proper management, be attended with great advantage in throwing additional light on different branches and modes of cultivation, as well as in bringing agriculturists acquainted with a variety of new and interesting facts.

When conducted under a proper system of management, farms of this kind might readily ascertain the following important questions.

- 1st. What is the best mode of cultivating arable land?
- 2d. What is the best system for the management of grass land?
- 3d. What are the most useful implements of husbandry?
- 4th. What are the most profitable breed of animals, and the best, and cheapest modes of feeding and fattening them?
- and,
- 5th. What is the best plan for rendering waste or barren land productive?

All these questions are evidently to be considered in relation to the differences of soils, circumstances and situations.

Mr. Arthur Young, in speaking of the establishment of a farm of this nature, as being properly an undertaking only fit for a sovereign, in the fourth volume of his "Annals of Agriculture," remarks, that it would have great effects in promoting agriculture in this country, but in others, where that art is still less understood, it is absolutely essential to the progress of it. And that if, in some future age, this art, so necessary to the welfare of mankind, should receive an attention that has hitherto been denied it, and a farm of this sort should be established, the following hints may be found of use. It is conceived, that a divided attention to complex questions should be avoided; and those great leading objects most nearly connected with the deficiencies of the national agriculture demand the first exertions to ascertain. With this view the soil of the farm should regulate the plan of it. If it were a sand one in this country, it should, it is supposed, be thrown into the Norfolk husbandry, and the object of these experiments would be to examine how far that system, by means of carrots, turnip-cabbage, and other new plants, equi-distant drilling, manuring for the roots and grasses instead of the wheat, &c. could be improved. And connected with this inquiry would be the collateral one of the breed of sheep, proper for this soil; with other objects too numerous to recite, which are at present unascertained.

If the soil were of the clayey or loamy kind, too wet for turnips, the great objects would, it is supposed, be, the means of banishing summer fallows, an inquiry of great importance; the culture and use of cabbages; the modes of draining by hollow cuts and arched lands; the best means of converting such lands to meadows, and the proper breed of cattle.

And on a loamy soil, strongly inclining neither to clay nor sand, very interesting inquiries are to be pursued. Every plant, common on all other soils, is to be cultivated on this. The rotations of crops; the culture of potatoes and carrots, and their application to all sorts of cattle; lucerne, and its use in summer feeding a dairy of cows, that are supported in the winter on the roots, &c. are among the numerous inquiries

to be prosecuted on this sort of soil. On chalky soils the principal object is, it is supposed, the culture of saintfoin, and the best means of converting it to corn and turnips preparatory to a renewal.

But on a peat-moor many dubious points are to be ascertained; the best means of reclaiming, whether by paring and burning, fallow, or mere manuring. The grasses proper to lay down with; and the means by roots or cabbages, of supporting the greatest possible stock of that breed of cattle and sheep, which are found by experiment most proper for the soil; the method of draining, manuring, and giving solidity to bogs, &c. Upon all, or either of these soils, collateral inquiries would arise in relation to manures, tillage, instruments, &c. and a great variety of doubtful points to be decided in the culture and management of all the plants usually raised on any of them.

A small botanical garden of two or three acres, under a botanist, for small experiments upon plants not cultivated but promising; and a laboratory for chemical trials on soils, manures, and vegetables, would, it is suggested, be two necessary additions to such an establishment; and with a smith's and wheelwright's work-shop would render the whole complete.

The great features of such a plan would, it is supposed, be of utility; it would, however, be susceptible of no inconsiderable ornament. The lines of the inclosures might be decorated in any imaginable way, provided the contents of the field applicable to useful grass or corn were traced by right lines. Every tract of land, of a considerable extent, has some broken ground, steep slopes, water-courses in glens, or pieces where the plough cannot move with convenience, and where grass is not an equal object with more level spaces; these, by a judicious disposition of the ground, might be connected with the margins of the fields, and, by walks being traced through them, might be made highly ornamental and pleasing. It is suggested that one of Brown's winding walks, with its usual accompaniment of shrubs and velvet lawn, surrounding thirty, forty, or more acres of grass, is never seen, but it brings to the mind the variety such a space is capable of, by being thrown into experiments that yield a food for the mind as well as the eye. Some delicious spots, it is true, unite so happily in all their parts, melting by an easy gradation into so rich a harmony of distribution, that any change would offend as much as dissonance in a piece of pleasing music. But such spots are rare: in general, the variety of neat and elegant experiments would not injure the effect at all. The Leasfowes was, it is stated, in all its parts, a farm, and much more agreeable to the eye, than if the whole had been lawn. But in the present system of decorating ground, variety of effect is wanting; something to bring variations to the scene, in which the owner shall be interested: The lawn that was smooth yesterday is smooth to day, and the revolution of the seasons that bids the rose breathe its perfume in June, and wither in November, brings to the eye a succession of the same images which please this year, as they pleased the last, without novelty in the cause, or increase of pleasure in the effect. The highest decoration of landscape will not give it the power of variety; it will be the same this August as it was the last; it will be gay in summer; and dreary in December; its forcible effect is for others not yourself; for at every repetition of viewing the colours fade, and what once excited rapture, now brings no other emotion than cold approbation. The beauty of a mere garden-scene is like that of a fine face; it moves admiration at first, and we feel ourselves under the enchantment of a spell that chains all our senses; but let the enchantress speak, and prove herself a

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pretty fool, the inanity of her conversation breaks the spell, and she is from that moment less than a pretty picture, since no one claims a merit in making her. The beauty of a garden-scene is much of the same kind; it holds little conversation with you; it suggests no new ideas; it furnishes no food to an inquisitive mind. If a person be told that he may contemplate the works and wisdom of God; and hold converse with the vegetable and animal creation, he replies, not because he is in a garden, for a nettle is as wonderful a production of divine power as a lily, and the structure of a toad an object to philosophize on, as much as a nightingale. Hence the contemplative pleasures of a decorated scene are not appropriated; they arise from the parts and not the combination; and therefore, in this respect, might as well not be combined at all. But when the ornamented walks lead you to something that offers novel information with every season, when you are in the pursuit of unknown facts, to ascertain which is to promote not your own solitary pleasures and contemplations only, but a science intimately connected with the prosperity of a nation; when every inclosure is pregnant with instruction, the field of a pursuit, and consequently of a pleasure; in such a case, it is not a question of an arrangement of a lawn, and water, and shade, that shall please the eye for a time; it is not the bloom of a flower, or the bend of a walk, but a subject where the renovation of the year brings perennial employment for the mind: your landscape becomes the source of thought; the eye may be pleased, but the understanding is satisfied; and instead of modes of duration that have been repeated to satiety, a novel scene is created, at once the theatre of private pleasure and public instruction; where useful knowledge is sought, not in vain theories, and indolent speculation, but in the vigour and activity of experimental exertion. Compared with such an application of a tract of land, what are parks and gardens, shrubberies and decorated grounds, but so many baubles to please children; frivolous efforts to fill the eye, but leave the mind vacant. The prince that raises palaces, and embellishes the gardens that surround them, may be commended for his taste, and praised for his magnificence. Versailles was called a creation; but had Lewis XVI. established such a farm as has been described; had the experiments been registered and published for the benefit of France; how little would the reputation of that creation now be found, compared with the genuine and never dying fame that would have sprung from a different application of the same ground. The prince that rears a palace, does what princes have done before him; but he who founds an establishment for the instruction of his people in the most necessary of all arts, does that which none have done before him, and deserves a title more truly valuable than that of *Great*, so often ill applied to the destroyers, not the protectors, of humanity; he will enjoy the title of the "Friend of Mankind."

A late writer on modern husbandry, however, seems to think more favourably of this method of bettering the state of agriculture than the author mentioned above, as he considers it as a mean by which a general spirit for such improvements may be the most effectually introduced. It is a measure, he supposes, which there is every reason to believe would be attended with good consequences, in regard to the determining with exactness the proper quantities of the different sorts of manures that ought to be applied to the different kinds of soils; the sorts best adapted to each; and the effects they produce when applied singly or in their compound state. But the utility of public experimental farms in every county, if put under the direction and management of persons of extensive knowledge and experience, should

not, it is contended, be estimated by a reference to any particular branch: husbandry, in all its departments, would be greatly improved in this way; and should the period ever arrive when the obstacles that stand in its way shall be removed, and proper means be had recourse to, for diffusing a general knowledge of the best methods of conducting the various operations connected with that science, that which has been suggested must not be overlooked. It is supposed that such sorts of farms would become so many seminaries, at which youth might be instructed in the nature, principles, and practice of agriculture, and to which the common farmer might occasionally resort for information, in respect to the success of experiments made as it were under his own eye, and on soils, in situations similar to those of his own.

And the author of "Rural Economy of the Midland Counties," in speaking of the advantages of these sorts of farms, asks, "what man, whether of the superior class of yeomanry or tenants, or of a superior class of tradesmen or others, who are now bringing up their sons to husbandry, would not, after his son had gone through a course of private tuition, and received the rudiments of instruction from himself or some professional friend, wish to perfect his education in a public seminary; where he would have not only an opportunity of seeing practice in its highest state of improvement, and of conversing with professional men of the most enlightened understandings; but where he would be duly initiated in the theory of rural knowledge, in the method of making, registering, and observing the result of experiments; of ascertaining the inherent qualities, and improving the various breeds of live stock; where he would see order and subordination, and learn the proper treatment of servants; and among a variety of other branches of useful knowledge, the form and method of keeping farm-accounts, and of ascertaining with accuracy the profit or loss upon the whole, and every part of his business; consequently of bringing it, as nearly as in its nature it is capable of being brought, to a degree of certainty."

But whatever may be the opinion of some concerning the utility of public establishments of this nature, we are inclined to believe that they will be found more beneficial when under the direction and management of private individuals who are sufficiently qualified for such undertakings, for though they may be far less extensive, they will be much more usefully conducted from their being less subject to those improper checks and controuls, which are continually taking place when a number of persons are concerned.

*EXPERIMENTAL philosophy.* Pythagoras is said to have been the first person who called himself philosopher, viz. a lover of knowledge or wisdom, from the Greek words φίλος, a friend or lover, and σοφία, knowledge or wisdom; from which appellation the word philosophy was derived, meaning the love of general knowledge; and according as this knowledge relates to the manners, the duties, and the conduct of human beings, considered in a rational and social light, or to the phenomena of natural bodies, so it has been called either *moral philosophy* (from the Latin *mos* or *mores* its plural, which means *behaviour* or *manners*) or *natural philosophy*.

The philosophers of the primitive ages, among the Greeks, Romans, &c. in explanation of the phenomena of nature, such as the motions of the celestial bodies, the rain, snow, frost, thunder and lightning, the rainbow, the combustion of fuel, the production of animals and vegetables, and so forth, generally offered the inadequate suggestions of their imaginations, which, though mostly unintelligible, and frequently absurd in the greatest degree, were nevertheless received with deference by their scholars, and were propagated with

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with fidelity or diligence from one generation to another. Their acquiescence rested merely on the authority of the teacher. That these explanations were generally inadequate and absurd, is easily evinced by observing that different contemporary philosophers entertained and taught opinions diametrically opposite to each other, though they related to the very same question; and that subsequent philosophers have by actual observations, and unerring demonstrations, shewn their fallacy. It may amuse an inquisitive mind to observe, that whilst the exertions of the early mathematicians, whose productions have obtained the admiration of subsequent generations, were strictly rational and correct, the investigations of their contemporary philosophers were conducted in a manner altogether slovenly and superficial. This method of philosophising prevailed for a very long period, and in consequence of it several centuries elapsed, during which the knowledge of nature made no progress deserving of notice, excepting a few rare and accidental discoveries.

The 15th century, which was productive of the greatest events and the most consequential discoveries that history can record, seems to have given a new turn to the subject of natural philosophy. The old tenets began to be doubted, and the energies of the human mind began to manifest their unfettered powers. In the next century, the incoherent dogmas of the preceding ages were freely combated; the authority of names and sects was disregarded, and in lieu of opinions, the explanation of natural phenomena was referred to the evidence of actual experiments; and this introduced the appellation of *experimental philosophy*, meaning the knowledge of natural powers and natural effects, acquired by means of experiments or trials. The least reflection readily shewed the superiority of this new method of philosophising; but, independent of any other consideration, its establishment is principally due to the success with which it was attended, and which exceeded even the most sanguine expectations of its first promoters; for it was no sooner adopted, than discoveries of importance were made, old-established errors were detected, and the subject of philosophy assumed an entirely new aspect.

It is undoubtedly true, that in this mode of investigation the experiments must be preceded by hypothesis, or supposition; for a man cannot begin to make experiments without the previous formation of a certain plan; but then the plan, the supposition, or the hypothesis goes no farther than to propose something, the confirmation or refutation of which is referred to the result of experiments, assisted by mathematical calculation.

In the 13th century, the necessary preliminaries for the improvement of natural knowledge began to be made; *viz.* collections of what then prevailed under the denomination of scientific knowledge, natural knowledge, secrets of nature, and the like; and the farrago of truths, errors, inconsistencies, doubts, and perplexities, which these works contain, is strange indeed. Among the few who effectually began to work in the experimental mode of investigation, during that century, friar Bacon held the most distinguished place. His desire of information was great; his views extensive; his mind clear and capacious; and he is said to have spent about 200*l.* (a sum very considerable at that time) in the performance of his numerous philosophical experiments. Baptista Porta also distinguished himself for similar pursuits in Italy. This inquisitive person lived at Naples, and about the year 1560 formed a society of scientific persons, who met in his own house. The great Galileo, who was born in Italy in the year 1564, became famous as a philosopher and a mathematician towards

the latter end of that century and the beginning of the next. His genius, superior to the prejudices of the times, investigated and established several leading propositions in natural philosophy; and his success, his example, and his precepts disseminated an universal ardour for the true mode of investigating the powers and the effects of natural bodies. His successor, Torricelli, was not unworthy of a most distinguished rank amongst the philosophers of the age; and the Torricellian tube, or the barometer, is a magnificent monument of his experimental inquiries.

In England, as we have already mentioned, friar Bacon was the first promoter of true knowledge; but a great part of the work of philosophical reformation was accomplished by another inquisitive genius of the same name. Francis Bacon, lord chancellor of England, gave a fresh and vigorous impulse to the progress of experimental enquiry. He recorded a vast number of facts, proposed and executed a great many experiments; and nothing that related to nature seemed to be below his notice.

These early reformers of philosophy, besides other obvious difficulties, were obliged to struggle against, and the success of their labours was much impeded by, the wrong notions which then prevailed, and which had been long rooted in the minds even of the most able persons then living. Galileo was nearly oppressed by the ignorance and prejudices of the clergy. Crichton, who flourished about the latter end of the 16th century, wrote an able book expressly against the vain philosophy of Aristotle, which had long been read in the schools. The two Bacons, and other able writers, frequently allude to, and strenuously endeavour to remove, the wrong notions of their contemporaries, and, in short, the demolition of the old defective fabric, proved nearly as laborious as the erection of the new structure.

The reform which had been begun by the above-mentioned and other worthy persons was soon after completed by the extraordinary genius of Newton. This truly great man, like a luminary of the first magnitude, illustrated whatever came within the limits of his notice, and his notice was employed in the greatest and most admired works of the creation. His method was to institute experiments, to examine the phenomena with accuracy, and to ground upon them the strictest mathematical reasoning. The conviction which such rational method conveyed, and the numerous discoveries with which it was attended, completely exploded the old tenets, and established the only true method of investigating nature.

The progress of experimental philosophy might have been interrupted by the death of a single individual; for it does but seldom occur that genius, health, opulence, and other opportunities concur in the qualification of an experimental philosopher; but the danger was in great measure averted by the institution of philosophical societies, which, by uniting the efforts of several ingenious labourers, by furnishing in great measure the means of investigation, by encouraging improvements, and by recording and propagating the results, have established the progress of knowledge in a regular and permanent channel.

The first society of the kind which we find recorded, is that which we have already mentioned at the house of Baptista Porta in Naples, towards the latter end of the 16th century. It was called "Academia Secretorum Naturæ." Next to this, and before the end of the same century, the Academy, called of the Lyncei, was founded at Rome, and was rendered famous throughout the world principally by the renown of one of its members, the great Galileo. The Academy del Cimento, and several other associations of scientific persons, were established in the succeeding, *viz.*

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the 17th century. And amongst those associations the first rank must be assigned to the Royal Society of London. This most learned and distinguished society had its origin soon after the middle of the 17th century. A few men of learning began to meet at stated times in Wadham college, Oxford; and among those persons there were the following conspicuous characters; *viz.* Dr. Ward, Robert Boyle, Dr. Wilkins, sir William Petty, Mr. Matthew Wren, Dr. Wallis, Dr. Goddard, Dr. Willis, Dr. Bathurst, Dr. Christopher Wren, and Mr. Rooke. From Oxford this association transferred its meetings to Gresham college in London, which took place in the year 1658. There they increased their number, and soon after the restoration of Charles II. that society received a royal charter, which established it into the form that has been continued ever since; but we must refer the reader to other articles of this Cyclopædia for the particular account of the Royal Society of London, as well as of other scientific associations in this and other countries; and at the same time we must proceed to explain the new mode of philosophizing in a manner somewhat more particular.

The objects of the universe, or the natural bodies, which affect our senses, become known and useful to us by their properties, some of which affect one of our senses, whilst others affect some other sense. Thus we perceive luminous bodies through our eyes, sound through our ears, heat or cold by the touch or feel, &c. Some of these properties are called general, like gravity and extension, because they belong to all bodies; and others, like transparency and fluidity, are called particular, because they belong to certain bodies only. The better we become acquainted with the properties of natural bodies, the more extended the sphere of our powers and of our advantages becomes; and it is for the discovery of these properties, either in simple or in compound bodies, that experimental inquiries are instituted.

In the acquirement of knowledge, the human being has no other assistance besides that of his senses, and of his reasoning faculty. By the first he observes and acquires ideas of self evident propositions, or properties of natural bodies; such as the human mind cannot dissent from without manifest violence; by the second he is led from one of these evident simple propositions, to another strictly depending upon the first, then to a third strictly depending upon the second, and so on, to the acquisition of some idea more complex, and less apparent at the first annunciation.

The constant observations of philosophers, with sir Isaac Newton at their head, and the dictates of plain reasoning, have furnished certain axioms and certain rules of philosophizing, the propriety of which is too evident to be objected to.

The axioms of philosophy, or the axioms which have been deduced from common and constant experience, are so evident, and so generally known, that it will be sufficient to mention a few of them only.

1. Nothing has no property; hence
2. No substance, or nothing can be produced from nothing.
3. Matter cannot be annihilated, or reduced to nothing.

The propriety of the last axiom may perhaps be not readily admitted by certain persons; observing that a great many things appear to be utterly destroyed by the action of fire; also that water may be caused to disappear by means of evaporation, and so forth. But it must be observed, that in these cases the substances are not annihilated; they are only dispersed, or removed from one place to another, and by being divided into particles very minute, they elude our

senses, and escape our immediate notice. Thus, when a piece of wood is placed upon the fire, the greatest part of it disappears, and a few ashes only remain, the weight and bulk of which do not amount to the hundredth part of the weight and bulk of the original piece of wood. In this case the piece of wood is divided into its constituent principles, which the action of the fire drives different ways. The fluid part, for instance, becomes steam, the light coaly part either adheres to the chimney, or is dispersed through the air, &c. so that if, after the combustion, the scattered materials were collected, (which may in great measure be accomplished,) the sum of their weights would equal the weight of the original piece of wood.

4. Every effect has, or is produced by, an adequate cause, and is proportionate to it.

It may in general be observed, with respect to these axioms, that we only mean to assert what has been constantly shewn, and confirmed by experience, and is not contradicted either by reasoning or by any known experiment. But we do not mean to assert that they are as evident as the axioms of geometry; nor do we in the least presume to prescribe limits to the agency of the Almighty Creator of every thing, whose power and whose ends are too far removed from the reach of our understandings.

Having thus stated the principal axioms of philosophy, it is in the next place necessary to mention the rules of philosophizing, which have been formed, after mature consideration, for the purpose of preventing errors as much as possible, and of leading the student of nature along the shortest and safest path to the attainment of true and useful knowledge. These rules are not more than four; *viz.*

1. We are to admit no more causes of natural things, than such as are both true and sufficient to explain the appearances.
2. Therefore to the same natural effects we must, as far as possible, assign the same causes.

3. Such qualities of bodies as are not capable of increase or of decrease, and which are found to belong to all bodies within the reach of our experience, are to be esteemed the universal qualities of all bodies whatsoever.

4. In experimental philosophy we are to look upon propositions collected by general induction from phenomena, as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be corrected, or may be shewn to be liable to exceptions.

With respect to the degree of evidence which ought to be expected in natural philosophy, it is but proper to remark that physical matters are not in general capable of such absolute certainty as the branches of mathematics. The propositions of the latter science are clearly deduced from a set of axioms so very simple and evident, as to convey perfect conviction to the mind; nor can any of them be denied without a manifest absurdity. But in natural philosophy we can only say, that because certain particular effects have been constantly produced under certain circumstances, therefore they will most probably continue to be produced as long as the same circumstances exist; and likewise that they do, in all probability, depend upon those circumstances. And this is what we mean by *laws of Nature*; *viz.* certain effects which are or have been uniformly produced by certain causes, as far as our observations reach.

We may, indeed, assume various physical principles, and by reasoning upon them, we may strictly demonstrate the deduction of certain consequences. But as the demonstration goes no farther than to prove that such consequences must necessarily follow the principles which have been assumed; the

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the consequences themselves can have no greater degree of certainty than the principles are possessed of; so that they are true, or false, or probable, according as the principles upon which they depend are true, or false, or probable.

The foundations of experimental philosophy, as we have already observed, are the properties of natural bodies, *viz.* of all those bodies, either solid or fluid, which in any way affect any of our senses: and since our senses are affected by the properties of these bodies, *viz.* by their extension, colour, hardness, transparency, &c. we cannot know any more of these bodies than what is manifested to us by such properties only as we are able to perceive. Were we furnished with other senses, we might discover other properties which would make us more intimately acquainted with the nature of such bodies.

Human art has not been able to discover more senses than those which every body knows; but it has, in great measure, improved some of those which we possess, and this alone is sufficient to point out the limited nature of our perceptions. Thus, for instance, the discovery of the microscope, and the telescope, have shewn us wonders of which our forefathers were utterly ignorant; and the number and variety of these wonders have increased in proportion as the above-mentioned instruments have been improved. The improvements of these instruments have been suggested by the discoveries that have been made respecting the refrangibility of light, and the properties of transparent bodies, and these have been made in consequence of the innumerable experiments that have been instituted by various intelligent persons. Thus it appears, that by means of trials and observations new facts are ascertained, which, besides their being immediately useful to the human species, furnish, at the same time, the means of making farther discoveries; and the treasures of the natural world are far, indeed, from a state of exhaustion. Hence the improvements and the discoveries of experimental philosophy proceed in a kind of increasing geometrical progression; unless they be impeded by some extraordinary occurrence.

In contemplating the intimate nature of natural bodies, when our mind goes beyond the bounds of our senses, (and our senses, even with the assistance of instruments and reasoning, are only capable of perceiving a few properties of those bodies;) we wander in the boundless field of probability and conjecture. Two principal hypotheses have been entertained with respect to the primitive component particles of bodies. One is, that the particles of each peculiar species of bodies are different from the particles of another species of bodies. Thus the primitive particles of gold are supposed to be different from the particles of calcareous earth, different from the particles of water, &c. The other hypothesis is, that there is one kind of primitive or original particles of matter, and that from the different arrangement of these ultimate particles, the various bodies arise. Experience shews that certain bodies, which, at first sight, appear to be absolutely different from each other, are, upon further examination, exactly of the same nature. On the other hand, a vast number of bodies are so distinct from each other, that no art has been able to form one of them from the particles of another; thus gold cannot be converted into a diamond, iron cannot be converted into lead, &c. The former of these observations seems to favour the second hypothesis; the latter seems to favour the first hypothesis; but it is not in our power to determine the real state of the matter.

With respect to the number of bodies, which, by our not being able to change one of them into the other, are called elementary, or primitive and distinct, the reader will find

sufficient information under the article ELEMENT; but it may be remarked in this place, that new bodies are frequently discovered in proportion as new instruments, and the improvements of science in general, furnish us with the means of discriminating them from others; hence we are naturally led to conclude, that most probably there may exist a vast number of other bodies, of which we at present have not the least suspicion. Some of these may perhaps be discovered hereafter, whilst others may remain utterly unknown to the human species.

The properties of natural bodies, which are the objects of research to the experimental philosopher, are either general, or particular. The general properties, which belong to all kinds of bodies, are, as far as we know, not more than six; *viz.* extension, divisibility, impenetrability, mobility, vis inertiae, or passiveness, and gravitation. We have said that these are the general properties as far as we know, because matter in general may possess other properties that are not yet come to our notice. And the same observation may be made with respect to the universality of these properties: for they are said to be general, because no body was ever found which wanted any one of them. But mankind are not acquainted with all the bodies of the universe, and even several of those which are known to exist, cannot be subjected to experiments.

The peculiar properties, *viz.* those which belong to certain bodies only, and not to others, are density, rarity, hardness, softness, fluidity, rigidity, flexibility, elasticity, opacity, transparency, the properties of light, the properties of heat, the properties of electricity, the properties of magnetism, and three other kinds of attraction, (independent of gravitation, of electricity, and of magnetism,) *viz.* the attraction of aggregation, which the homogeneous parts of matter have towards each other, or by which they adhere together; and such is the power by which two small drops of mercury, when placed contiguous to each other, rush, as it were, into each other, and form a single drop; the attraction of cohesion, or that power by which the heterogeneous particles of bodies adhere to each other without any change of their natural properties, such as the adhesion of water to glass, of oil to iron, &c.; and the attraction of composition, or of affinity, which is the tendency that the parts of heterogeneous bodies have towards each other, by which they combine, and form a body, differing more or less from any of its components.

It is to be remarked, that of all these properties we know their existence only, and some of the laws under which they act; but we are otherwise utterly ignorant of their nature and dependence.

The investigation of some of the above-mentioned properties, whether general or particular, has been carried much farther than the investigation of other properties. The results of these investigations have likewise been various, both in point of extent and of application. Some of them are so very extensive and so useful, as to form the foundations of very important branches of science or of art, under peculiar appellations. Thus, upon the mobility and the vis inertiae of bodies, the doctrine of motion, or dynamics, is grounded, which comprehends mechanics, hydrostatics, or the mechanical properties of fluids, pneumatics, &c. Transparency and the properties of light form the important foundation of optics. The attraction of affinity is the foundation of chemistry, as well as of various arts, and so forth. Whatever belongs to these properties, or to the extensive subjects that are grounded upon the same, will be found under the various articles of their peculiar denominations.

The phenomena of the universe, are the appearances which take place in consequence of the above-mentioned properties of natural bodies, together (respecting some of them at least) with some original impulse. The phenomena which take place amongst the luminous celestial bodies, properly so called, such as the stars, the planets, &c. are examined by a particular science called astronomy; the meteors, or the phenomena, which take place within the limits of the terrestrial atmosphere, such as shooting stars, northern lights, halos, rain, fogs, hail, winds, &c. form the subject of meteorology. The phenomena that take place upon the surface of, or within, the earth, are treated of under the comprehensive denominations of *vegetation, earthquakes, volcanoes, combustion, &c.* all which will be found explained under their appropriate articles.

**EXPERIMENTUM CRUCIS**, denotes a capital, leading, or decisive experiment; thus called, either, because like a cross or direction post, placed in the meeting of several roads, it guides and directs men to the true knowledge of the nature of the thing they are enquiring after; or as it is a kind of torture, whereby the nature of the thing is, as it were, extorted by violence.

**EXPIATION**, the act of suffering the punishments adjudged to a man's crimes, and thus paying off, or discharging the debt or guilt; and it is figuratively applied to the pardon procured for the sins of the penitent by the interposition and death of Christ.

The Romanists hold, that souls after death are sent to purgatory to expiate or atone for their sins. See **PURGATORY**.

**EXPIATION** is also applied to sacrifices offered to the Deity, to implore his mercy and forgiveness.

**EXPIATION**, the *Feast of*, among the Jews, called by our translators the *day of atonement*, was held on the tenth day of Tisri, or the seventh month of the Jewish year, answering to part of our September and October. It was instituted by God himself, Levit. xxiii. 27, &c. On that day the high-priest, the figure or type of Jesus Christ, entered into the most holy place, and confessed his sins; and, after several ceremonies, made an atonement for all the people to wash them from their sins. Lev. chap. xvi. See **SCAPE-GOAT**.

**EXPIATION**, among the *Heathens*; denoted a purification used for effacing or abolishing a crime, averting any calamity; and on a thousand other occasions, as purifying towns, temples, and sacred places, and armies, before and after battle.

It was practised with divers ceremonies: the most usual was ablution.

Expiations were performed for whole cities as well as particular persons. After the young Horatius had been absolved by the people for the murder of his sister, he was farther purified by several expiations prescribed by the laws of the pontifices for involuntary murders. Dion. Halicarnass.

**EXPILATION**, from *expilo, I rob*, in the *Civil Law*, the act of withdrawing or diverting something belonging to an inheritance, before any body had declared himself heir thereof.

This made a peculiar species of theft; for there could not properly be a theft in taking a thing not possessed by any body, or before the inheritance was accepted.

For this reason the Roman legislature introduced the action of expilation for the punishment of this crime.

Beside this meaning, it was used in a more special manner to signify a robbery committed by night; whence an

expilator was looked upon as a greater criminal than a common thief.

The expilators were so called from their robbing and stripping people of their cloaths.

**EXPIRATION**, in *Physiology*, is the act of expelling air from the lungs, produced by a diminution of the cavity of the chest. It is opposed to inspiration, in which air is drawn into the chest. See **RESPIRATION**.

**EXPIRATION** is also used figuratively, for the end of a term of time granted, or agreed on, or adjudged.

**EXPLEES**, in *Law*, the rents or profits of an estate, &c. See **ESPLEES**.

**EXPLICATION** of the *Subject of a Discourse*, in *Pulpit Oratory*, and in the composition of sermons, comes in the place of narration at the bar, and should be conducted in a similar manner. It should be concise, clear, and distinct, and in a style correct and elegant, rather than highly adorned. To explain the doctrine of the text with propriety, to give a full and perspicuous account of the nature of that virtue or duty which forms the subject of the discourse, is properly the didactic part of preaching; on the right execution of which much depends for all that comes afterward in the way of persuasion. The great art in succeeding in it is, to meditate profoundly on the subject, so as to place it in a clear and strong point of view. Consider what light other passages of scripture throw upon it; consider whether it be a subject nearly related to some other from which it is proper to distinguish it, consider whether it can be illustrated to advantage by comparing it with, or opposing it to, some other thing; by enquiring into causes, or tracing effects; by pointing out examples, or appealing to the feelings of the hearers; that thus a definite, precise, circumstantial view may be afforded of the doctrine to be inculcated. Let the preacher be persuaded, that by such distinct and apt illustrations of the known truths of religion, it may both display great merit in the way of composition, and, what he ought to consider as far more valuable, render his discourses weighty, instructive, and useful. Blair's *Lectures*, vol. ii. p. 297.

**EXPLICATIVE PROPOSITION**, in *Logic*. See **COMPLEX Proposition**.

**EXPLICITE**, in the *Schools*, something clear, distinct, formal, and unfolded.

The will or intention is said to be explicite when it is fully explained in proper terms; and implicite, when it is only to be learnt by deductions and consequences.

The Jews had not all an explicite knowledge of Jesus Christ, but they had at least an implicite one.

Such a testator has declared his will explicitly, *i.e.* in formal terms; there is no need to have recourse to explanations.

**EXPLOITS**, *BAY of*, in *Geography*, a bay of the Atlantic, on the east coast of Newfoundland. N. lat. 49° 45'. W. long. 55° 20'.

**EXPLOSION**. It is a matter of great moment, in military engineering, so to load, and indeed to construct, a mine, that it may explode with the greatest precision, and with the maximum effect. A variety of theories has been given upon this subject, but it would be out of place to notice the whole of what appertains thereto in this place; therefore we shall refer our readers to the word **MINE** for the particular detail of what relates to this subject, contenting ourselves with now offering a few remarks on the manner in which the explosion is usually effected.

It is of the first importance to ascertain, so nearly as may be practicable, what depth, and what weight of soil is to be removed by an explosion. This being done, the mine is

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formed, by a gallery leading to the chamber in which the powder is to be deposited in a very strong chest, let into a recess, and firmly secured in every part. Now, it being the nature of the rarefied air to escape by that part which may be the weakest, it is evident, that if a mine is made under a rampart, so as to be within six feet of the surface, while all the sides are thicker by far than that measurement, the explosion will be directed towards that part which is thinnest, and which from that circumstance is called "the line of least resistance."

But, in order to direct the explosion to that part, it will be necessary to consider whether the soil be every where alike; for if the superincumbent portion should be part of a large stratified rock, while the sides are of a loose, inadhesive substance, the latter, though measuring more in diameter, will give the line of least resistance, which, in such case, would follow the intencity, and create a false explosion. Hence explosions may be lateral as well as vertical.

It was formerly supposed, that the diameter of the entonnoir, or explosion, was equal to double the line of least resistance; but we find that *six times* that line may be exploded, by allowing a load of 300lbs. of gun-powder, duly concentrated, and fired in the middle of the mass, for every foot of the line of least resistance. We are not to infer from this, that 300lbs. will be requisite to lift one foot of soil; far from it; for as a cubic foot of excavation will contain only 75lbs. of powder, the above quantity (300lbs.) would require a space of exactly four cubic feet; the proportion would therefore be preposterous. But when we calculate upon large masses of soil, such as those prodigious cones thrown out from entonnoirs of great extent, we then find, that, to produce the completest explosion, an immense quantity of powder must be supplied.

It is self evident, that the power of the powder, according to the above scale, is only computed to that extent which may be necessary towards the ordinary purposes of military devastation; for if we were to contribute, *ad infinitum*, 300lbs. of gunpowder for every foot in the line of least resistance, we should be accumulating power only in arithmetical proportion, while the resistance would be increasing in a geometric ratio: of course the power must be in a regular state of comparative diminution, in proportion as the line of least resistance is increased; and this must, after a while, occasion the powder to be inert; or, if there should be any explosion, it could only follow the track of the train; its ignition to be sure might be felt partially, like that of a slight earthquake, but no superficial effects would be observable.

It has been already stated, that the powder must be lodged in bulk; and that it should be ignited at the centre. This may, perhaps, appear superfluous; but all military men know, that much powder is blown out of the muzzles of pieces without ever being ignited; and we have a most remarkable fact, a very recent one indeed, which shews that, unless in bulk; powder is not always sure to be fired *in toto*. The incident alluded to is as follows.

In the month of March of this year, (1809,) a barge was proceeding along the new cut, from Paddington, laden with casks of spirits and barrels of gunpowder. One of the crew, it is supposed, allured by the former, bored a hole for the purpose of drawing off a little wherewith to tipple. Unhappily the action of the gimblet set fire to the contents of that barrel, which the dishonest navigator had mistaken for one of spirits. The barrel exploded; and drove eleven other barrels, filled with gunpowder also, to the distance of near a hundred and fifty yards. It is curious, that

although the whole of the powder-barrels were together, indeed in contact, only that in question exploded.

Vauban gives us the following scale for exploding soils of various descriptions. He calculates, or perhaps found from experience, that for a cubic fathom (six feet) of soil, measuring in all 216 solid feet, the following proportions of gunpowder were needful.

1. Light earth, mixed with sand,	-	11lb.
2. Common earth	- - -	12
3. Strong sand	- - -	15
4. Clay, or fat earth,	- - -	16
5. Old, and good masonry	- - -	18
6. Rock	- - -	20

In following this calculation, we are to consider the entonnoir to be in diameter equal to only double the line of least resistance; and not according to a maximum explosion.

EXPLOSION, from the Latin *explodo*, is the act of driving out something with noise and violence. The causes, the report or noise, and the other effects of explosions, however insignificant they may appear at first sight, are nevertheless, when duly considered, of great consequence to the human species, and as such they have been carefully inquired into by divers philosophers. A variety of experiments have been instituted for determining the particulars that relate to them, and numerous conjectures have been offered in explanation of these concomitant circumstances, which have not as yet been thoroughly investigated.

Explosions may be distinguished into natural and artificial. The principal natural explosions are those of the atmospheric thunder, of volcanoes, of earthquakes, and to these there may be added the inferior explosions arising from hard frosts. The artificial explosions are such as are produced by the force of fired gunpowder in the various engines in which it is used, the explosions produced by other chemical compounds, and the pneumatic explosions; meaning those which are produced by the air rushing into a partial vacuum, by the discharge of air-guns and the like.

Of all these kinds of explosions we shall now briefly treat, not in the order in which they have been enumerated, as this would prove a useless formality; but in a manner which may be more likely to elucidate the most interesting part of the subject; and this undoubtedly is the stupendous force with which effects, in great variety, are produced in certain explosions.

The first thing that strikes the observer is the sudden and violent noise of an explosion. It is hardly necessary to observe that this noise or report is owing to the intermediation of the air between our ears and the cause, whatever that may be, of the percussion which is given to the air. Without that intermediation, or without air, the report could not be heard. But it must be farther observed, that the mere introduction of something into the ambient air is not the principal cause of the report. That effect principally depends upon the sudden replacing or collapsing of the air, after its having been removed or rarefied in any particular place. So that in order to account for the immediate cause of the noise in an explosion, we must look out for something which after having been introduced into the atmosphere, whether slowly or quickly, is afterwards *suddenly* withdrawn or contracted. A few examples will easily illustrate this observation.

Take a common syringe, stop the aperture of it, then draw the piston entirely out of its other extremity, and at that moment a report is heard, which is occasioned by the replacing of the air within the syringe; for in drawing the piston out of it, the air within the cavity of the syringe is rarefied,

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rarefied, *viz.* a partial vacuum is formed, but as soon as the piston is quite out, the air of the atmosphere suddenly rushes in to supply that deficiency, and produces the noise or the report.

There is an experiment commonly shewn with the air-pump, and a glass vessel open at both ends. To one of the apertures of the glass vessel a wet piece of bladder is tied, and is suffered to become dry. The other aperture of the glass vessel is then placed upon the plate of the air-pump. This done, the air is extracted by working the pump, by which means the glass vessel covered over with the bladder is partially exhausted, and of course the pressure of the atmosphere is in great measure removed from the under surface of the piece of bladder. The atmosphere, then pressing on the upper part of the bladder, and not being counteracted from below, distends the bladder towards the cavity of the vessel, and at last breaks it with a considerable explosion. The reason of which noise is the sudden rushing in of the air.

An air-gun, when discharged, produces a trisling noise, the reason of which is, that after the expulsion of the condensed air from the inside of the instrument, which is impelled against the ambient air, there is no collapse of the latter; for the condensed air, on coming out of its confinement, expands itself to the tension of the ambient air, and remains in that state; *viz.* without any subsequent contraction.

There are little glass balls, containing a small quantity of water, which are made and sold for diverting experiments, under the name of *glass granades*. A ball of this kind is nothing more than a diminutive glass bottle partially filled with water, and having a longish neck or tail, hermetically sealed. One of these little bottles is stuck with its tail into the tallow or wax of a burning candle, and so that the little ball may be in the flame of the candle. In this situation the heat of the flame converts part of the fluid within the ball into vapour, and when the elasticity of this vapour is sufficient to overcome the resistance of the glass the ball breaks, and produces a smart explosion. The reason of which is, that the condensed vapour, on coming out of the glass, displaces a considerable quantity of air, but being instantly cooled, it contracts, and the air collapses.

A musket loaded with gunpowder, on being fired off, produces a strong explosion. Now the difference between the discharge of such a musket and that of an air-gun is, that though in both an elastic fluid is discharged; yet in the musket the elastic fluid contracts immediately after its coming into contact with the external air: but with the air-gun, the elastic fluid which issues out of it does not contract after its expulsion; hence the report is incomparably louder with the former than with the latter.

An electric spark, especially in the discharge of a Leyden phial or battery, is accompanied with a smart report, in consequence of its suddenly displacing the air from the spot in which it explodes; and of the subsequent collapsing of the air. And that the electric spark really displaces the air, is easily shewn by means of an electrical instrument, called "Kinnorsley's electrical air thermometer." In this instrument the spark is taken into a close glass vessel, which by an annexed narrow tube, partially filled with a liquor, indicates the rarefaction or displacing of the air within the vessel. With this apparatus, whenever a spark or discharge of an electric jar is taken within the close vessel, the rising and falling of the liquor within the annexed tube shews that the air is suddenly displaced, and is likewise heated in some degree; for the liquor rises suddenly to a certain degree; and as suddenly descends, not quite to its former station, but to a place a little above it, from which afterwards it descends gently to its original station.

From these facts, and from a vast many more which might here be described, it clearly appears that the sudden introduction of something into the ambient air produces little noise; but that the noise of an explosion is mostly due to the collapsing of the air, which takes place in consequence of the instantaneous contraction of that which has been introduced in it. The noise, *ceteris paribus*, is more or less loud in proportion as a greater or lesser quantity of air is displaced and replaced, and likewise in proportion to the quickness of that operation.

When more reports than one are heard; these are produced either by an equal number of explosions, or by a reverberation, *viz.* by an echo.

The air thus agitated conveys the sound of an explosion, or propagates its own vibrations, to immense distances. The firing of heavy ordnance has been sometimes heard at the distance of 50 or 60, and even more miles. The explosions of volcanoes, or those which accompany earthquakes, have often been perceived at distances much more considerable; but with respect to the extent of this kind of communication, rate of moving, &c. the reader is referred to the article *SOUND, propagation of, and HEARING*. We shall, however, in this place, briefly mention an effect of this kind of violent aerial vibration: which it might be wished that such persons as are opportunely situated, would examine with particular attention. The phenomenon is, that the explosion of cannons, and especially of powder magazines, or powder mills, renders the air considerably electrified, and that it electrifies the glasses of windows.

After the noise, or the report, the next step is to inquire into the cause or causes which produce it: *viz.* into the nature of the elastic fluid which, in coming out of any confinement, displaces the circumambient air, and then suddenly gives way to it. Until very lately the immediate cause of most explosions was principally attributed to the generation or extrication of permanently elastic fluids, *viz.* gases; and this is undoubtedly true in a great many cases; but upon a closer examination of the concomitant particulars, the expulsion of these elastic fluids, even in a state of incandescence, was found inadequate to the effects that were experienced in a variety of cases; hence philosophers began to look out for some other agent more active; and though the force of steam was known to be concerned in some kinds of explosions; yet it must be acknowledged, that we are indebted to count Rumford for a masterly examination of this particular point; for which purpose he instituted a long and laborious series of well contrived experiments. His account at large under the title of "Experiments to determine the Force of fired Gunpowder," is contained in the *Phil. Transf.* for the year 1797, and from that account we shall extract such particulars as may seem sufficiently to illustrate this important part of the subject of explosions. We call it important, because it is the particular from which the causes of natural explosions, such as of volcanoes, earthquakes, &c. may be obviously manifested.

Count Rumford justly says, "The explosion of gunpowder is certainly one of the most surprising phenomena we are acquainted with, and I am persuaded it would much oftener have been the subject of the investigations of speculative philosophers, as well as of professional men, in this age of inquiry, were it not for the danger attending the experiments; but the force of gunpowder is so great, and its effects so sudden and so terrible, that, notwithstanding all the precautions possible, there is ever a considerable degree of danger attending the management of it."

Several able philosophers had, at different times, endeavoured to determine the force of it. "But," count Rum-

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ford says, "the great desideratum, the real measure of the initial expansive force of inflamed gunpowder, so far from being known, has hitherto been rather guessed at than determined; and no argument can be more convincing to shew our total ignorance upon that subject, than the difference in the opinions of the greatest mathematicians of the age, who have undertaken its investigation."

The ingenious Mr. Robins thought, that the force of the elastic fluid, which is generated in the combustion of gunpowder, is 1000 times greater than the mean pressure of the atmosphere. Mr. D. Bernoulli reckoned it equal to 10,000 times that pressure.

Count Rumford, in one of his first experiments, confined gunpowder in a strong iron tube, and fired it by heating part of the tube, or rather of an appendage that had been fixed to it. This was done with a view of confining the elastic fluid, that was generated in the combustion. "The result," he says, "of this experiment fully answered my expectations. The generated elastic fluid was so completely confined, that no part of it could make its escape. The report of the explosion was so very feeble, as hardly to be audible: indeed it did not by any means deserve the name of a report, and certainly could not have been heard at the distance of twenty paces; it resembled the noise which is occasioned by the breaking of a very small glass tube."

And farther on, he says, "It has generally been believed, after Mr. Robins, that the force of fired gunpowder consists in the action of a permanently elastic fluid, similar in many respects to common atmospheric air: which being generated from the powder in combustion, in great abundance, and being, moreover, in a very compressed state, and its elasticity being much augmented by the heat, (which is likewise generated in the combustion,) it escapes with great violence, by every avenue; and produces that loud report, and all those terrible effects which attend the explosion of gunpowder."

"But though this theory is very plausible, and seems upon a cursory view of the subject to account in a satisfactory manner for all the phenomena, yet a more careful examination will shew it to be defective. There is no doubt but the permanently elastic fluid generated in the combustion of gunpowder, *assists* in producing those effects which result from its explosion; but it will be found, I believe, upon ascertaining the real expansive force of fired gunpowder, that this cause, alone, is quite inadequate to the effects actually produced: and that, therefore, the agency of some other power must necessarily be called in to its assistance."

This author then proceeds to describe a variety of experiments and calculations which prove, beyond a doubt, that the above-mentioned theory is insufficient to account for the effects which are produced by the inflammation of gunpowder; for he computes, in the amplest manner possible, the force of the gas which is generated even in the heat of red-hot iron, by which elevation of temperature air is known to be expanded not much above four times its ordinary bulk. He endeavoured to measure the force in question by the lifting up of a very great weight, and his ingenious experiments were attended with results sufficiently satisfactory; but we must refer the reader to the above-mentioned paper itself for the detail of these interesting particulars; and we must here only add an abridgment of the latter part of the account, which more immediately relates to the principal object of our present enquiry.

"I will finish," the Count says, "this paper by a computation, which will shew that the force of the elastic fluid generated in the combustion of gunpowder, enormous as it

is, may be satisfactorily accounted for upon the supposition that its force depends *solely* on the elasticity of watery vapour or steam.

"It has been shewn by a variety of experiments made in England, and in other countries, that the elasticity of steam is redoubled by every addition of temperature equal to 30 degrees of Fahrenheit's thermometer.

"Supposing now a cavity of any dimensions (equal in capacity to one cubic inch for instance) to be filled with gunpowder, and that on the combustion of the powder, and in consequence of it, this space is filled with steam (and I shall presently shew that the water existing in the powder *as water* is abundantly sufficient for generating this steam); if we know the heat communicated to this steam in the combustion of powder, we can compute the elasticity it acquires by being so heated.

"Now it is certain that the heat generated in the combustion of gunpowder cannot possibly be less than that of red-hot iron. It is probably much greater, but we will suppose it to be only equal to 1000 degrees of Fahrenheit's scale, or something less than iron visibly red-hot in day light."

"As the elastic force of steam is just equal to the mean pressure of the atmosphere, when its temperature is equal to that of boiling water, or 212° of Fahrenheit's thermometer, and as its elasticity is doubled by every addition of temperature equal to 30 degrees of the same scale, with the heat of 212° + 30° = 242° its elasticity will be equal to the pressure of two atmospheres; at the temperature of 242° + 30° = 272° it will be equal to four atmospheres, &c.

"Following up our computations on the principles assumed, (and they are founded on the most incontrovertible experiments,) we shall find that at 692° + 30° = 722°, the elasticity will be equal to the pressure of 131,072 atmospheres, which is 130 times greater than the elastic force assigned by Mr. Robins to the fluid generated in the combustion of gunpowder; and about *one-sixth* part greater than my experiments indicated it to be.

"But even here the heat is still much below that which is most undoubtedly generated in the combustion of gunpowder. That the elasticity of steam would actually be increased by heat in the ratio here assumed, can hardly be doubted; it has absolutely been found to increase in this ratio in all the changes of temperature between the point of boiling water, (I may even say of freezing water,) and that of 280° of Fahrenheit's scale, and there does not appear to be any reason why the same law should not hold in higher temperatures.

"A doubt might possibly arise with respect to the existence of a sufficient quantity of water in gunpowder, to fill the space in which the powder is fired, with steam, at the moment of the explosion, but this doubt may easily be removed.

"The best gunpowder, such as was used in my experiments, is composed of 70 parts (in weight) of nitre, 18 parts of sulphur, and 16 parts of charcoal; hence 100 parts of this powder contain 67  $\frac{1}{10}$  parts of nitre, 17  $\frac{3}{10}$  parts of sulphur, and of charcoal 15  $\frac{1}{10}$  parts.

"Mr. Kirwan has shewn that in 100 parts of nitre there are seven parts of water of crystallization; consequently in 100 parts of gunpowder, as it contains 67  $\frac{1}{10}$  parts of nitre, there must be 4  $\frac{7}{10}$  parts of water.

"Now as one cubic inch of gunpowder, when the powder is well shaken together, weighs exactly as much as one cubic inch of water at the temperature of 55° F. namely 253,175 grains troy; a cubic inch of gunpowder in its driest state must contain at least 10  $\frac{9}{10}$  grains of water;

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for it is 100 to 4,711, as 253,175 to 10,927. But besides the water of crystallization which exists in the nitre, there is always a considerable quantity of water in gunpowder, in that state in which it makes bodies damp or moist. Charcoal exposed to the air has been found to absorb nearly  $\frac{1}{3}$ th of its weight of water, and by experiments I have made on gunpowder, by ascertaining its loss of weight on being much dried, and its acquiring this lost weight again on being exposed to the air, I have reason to think that the power of the charcoal, which enters into the composition of gunpowder, to absorb water, remains unimpaired, and that it actually retains as much water in that state as it would retain were it not mixed with the nitre and the sulphur.

“As there are  $15\frac{4}{5}$  parts of charcoal in 100 parts of gunpowder, in one cubic inch of gunpowder, (= 253,175 grains troy,) there must be 38,989 grains of charcoal; and if we suppose  $\frac{1}{3}$ th of the apparent weight of this charcoal to be water, this will give 4,873 grains in weight for the water, which exists in the form of moisture in one cubic inch of gunpowder.

“If now we compute the quantity of water which would be sufficient, when reduced to steam under the mean pressure of the atmosphere, to fill a space equal in capacity to one cubic inch, we shall find that either that contained in the nitre which enters into the composition of one cubic inch of gunpowder, as water of crystallization, or even that small quantity which exists in the powder in the state of moisture, will be much more than sufficient for that purpose.

“Though the density of steam has not been determined with that degree of precision that could be wished, yet it is quite certain that it cannot be less than 2000 times rarer than water, when both are at the temperature of  $212^{\circ}$ . Some have supposed it to be more than 10,000 times rarer than water, and experiments have been made which seem to render this opinion not improbable; but we will take its density at the highest possible estimation, and suppose it to be only 2000 times rarer than water. As one cubic inch of water weighs 253,175 grains, the water contained in one cubic inch of steam at the temperature of  $212^{\circ}$  will be  $\frac{1}{2000}$ th part of 253,175 grains, or 0.12659 of a grain.

“But we have seen that one cubic inch of gunpowder contains 10,927 grains of water of crystallization, and 4,873 grains in a state of moisture; consequently the quantity of water of crystallization in gunpowder is 86 times greater, and the quantity which exists in it in a state of moisture, is 38 times greater than that which would be required to form a quantity of steam sufficient to fill completely the space occupied by the powder.

“Hence we may venture to conclude, that the quantity of water actually existing in gunpowder is much more than sufficient to generate all the steam that would be necessary to account for the force displayed in the combustion of gunpowder, (supposing that force to depend solely on the action of steam,) even though no water should be generated in the combustion of gunpowder. It is even very probable that there is more of it than is wanted, and that the force of gunpowder would be still greater, could the quantity of water it contains be diminished.

“From this computation it would appear that the difficulty is not to account for the force actually exerted by fired gunpowder, but to explain the reason why it does not exert a much greater force.”

Besides the common gunpowder, there are several other chemical compositions which are capable of exploding

with greater or less violence; and the most remarkable of these compositions are, the gunpowder formed with the superoxygenated muriate of soda, instead of nitre; that preparation of gold which, from its remarkable property, is called fulminating gold; the fulminating silver, Howard's mercurial powder, the common fulminating powder, which consists of nitre, potash, and sulphur, &c. The explosions of almost every one of these chemical compositions is louder than the explosion of an equal quantity of the common gunpowder; yet when confined in a barrel or other fit instrument, few of these compositions exert a force, or produce an effect equal to that of gunpowder. This, which at first sight may appear to be an inexplicable paradox, will be easily understood by considering, that the smartness of the report depends in great measure on the quickness of the inflammation or explosion; whereas the force of the explosion is mostly proportional to the quantity of elastic fluid, be it gas or vapour, which is generated, and that the abovementioned chemical mixtures explode quicker than common gunpowder, may be easily proved. Let, for instance, two trains of equal length be formed upon a stone pavement; viz. one with the common gunpowder, and another with Howard's mercurial powder, and let one extremity of each train come into mutual contact; so that by applying a red-hot iron to that point, both trains may be fired at the same time. It will be found that the train of mercurial powder goes off visibly much quicker than that of gunpowder; for when the former is entirely consumed, the fire of the latter will hardly have proceeded half way of the whole train.

The explosion of the gunpowder made with the superoxygenated muriate of soda, and Howard's mercurial powder, exert an immense force when fired in barrels or other like vessels. Fulminating gold and fulminating silver explode very readily, especially the latter, which, when once prepared, can no longer be touched; for it will explode, not only when heated a few degrees above the temperature of the atmosphere, but even when touched with any solid body. Yet when either of these preparations is confined in a barrel or other like instrument, and is inflamed, the force which it exerts is by no means equal to that which one who has heard the noise of their explosions would be led to expect. It is worthy of remark, that, upon the whole, no other composition hitherto discovered has been found preferable to the common gunpowder, for muskets, cannons, and other instruments of the like nature. Most of these preparations are considerably more expensive than the common gunpowder; some of them are not nearly so manageable as the gunpowder, for they will explode by the least touch or grinding, even by the friction of the stopple into the neck of the vessel that contains them; but the principal fault is that very property by which they might be expected to have a superior power; namely, the quickness of their explosion.

There is a certain time requisite for the motion of the wadding and bullet from the lower part to the muzzle of a gun, and the gradual inflammation of the gunpowder, when used in proportionate quantity, seems to correspond with that gradual movement of the bullet, wadding, &c. When the exploding composition goes off much quicker than the common gunpowder, that force which is exerted spherically all round, and quicker than the time during which the wadding; &c. can get along the cavity of the barrel, frequently breaks the barrel, and endangers the bystanders. We cannot illustrate this effect better than by mentioning the common and well-known observation, that though an open door may be shut by a gentle application of a child's

a child's hand, yet if you point a gun, and fire a bullet at it, the latter will make a hole through it without shutting, or closing it in the least.

Speaking of the force of explosions, it may naturally be required that we should treat of the force and effects of electrical explosions. But as the nature of such explosions cannot be properly understood without other particulars relative to the subject of electricity, their force and effects will be found described under the articles which belong to that extensive subject; such as *ELECTRIC Sparks*, *LEYDEN PHIAL*, *FIRE Balls*, *LIGHTNING*, &c.

It is in a manner similar to the effects of gunpowder, that water projected upon red-hot or fused metal, occasions a most powerful, and most dangerous explosion. In both cases the water is instantly reduced into steam, at a high temperature, consequently of very high elasticity; hence the force which is exerted is often prodigiously great; and there are instances recorded of whole founderies having been instantly demolished, in consequence of some persons having inadvertently spit upon the liquid metal. If a small quantity of water be poured upon red-hot charcoal, or red-hot glass, a hissing noise is heard; the part which is touched by the water loses its redness, and nothing else remarkable takes place, because the above-mentioned substances are bad conductors of heat, and it is only that part which is touched by the water that communicates its heat to the water, and this is not sufficient to convert the water suddenly into steam of very great elasticity. But metallic bodies are the best conductors of heat, and fused copper is particularly so; hence, when a small quantity of water happens to fall upon a large quantity of that metal, in a state of fusion, the heat from a great part of the metal rushes to the spot where the water is fallen, and instantly converts it into steam of high elasticity.

The explosion of a mixture of hydrogen and oxygen gases, or of hydrogen gas and common air, does likewise exert a considerable force, but not to be compared with that of gunpowder. These gases, when inflamed, expand considerably, but instantly after, they contract into an exceedingly narrow compass, which occasions the report; for, by the combustion, they are converted principally into water, the bulk of which is less than the ten or twenty thousandth part of the original bulk of the gases.

The last kind of explosion we shall take notice of, is produced not by the generation or contraction of an elastic fluid, but by a sort of mechanical derangement. Those lumps of glass with a long tail, or prolongation, which are well known by the name of *Glass Tears*, or *Prince Rupert's Drops*, are an instance of this kind. If one of these drops be held in the hand, and part of the tail is broke, a smart kind of explosion is heard, and the whole is instantly converted into powder. In order to understand the cause of this phenomenon, it is in the first place necessary to consider how these drops are formed. For this purpose the glass manufacturers take a quantity of the fused glass, (about half an ounce of it, and green bottle glass is the fittest for it,) and drop it in that state of incandescence into cold water; the consequence of which is, that the external part of the lump of glass is cooled and rendered solid long before the internal part of it. Then when the internal part is cooled, and of course contracts its dimensions, the external part being already cooled and settled, cannot follow it, so that it remains in a state of suspension somewhat like an arch; hence, when part of the lump is broken, the key-stone, as it were, of the arch, is removed, and the whole assemblage of particles is de-

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ranged. See *GLASS Tears*, for a more detailed explanation of these their properties.

Several other substances explode and are broken upon analogous principles. Such are glass vessels made for different purposes, and especially for electrical machines; also large cast-metal vessels sometimes spontaneously explode and break in the act of cooling. Sir William Hamilton mentions certain volcanic bodies, which he calls *volcanic bombs*, that explode probably on the same principle. They were large pieces of lava, which burst in pieces like bombs as they fell to the ground. These were observed in the great eruption of mount Vesuvius, which took place in the year 1779. The cause of volcanic explosions, as well as of those which accompany or precede earthquakes, is mostly attributed to the action of steam; but these kinds of explosions will be found particularly examined under the articles *EARTHQUAKE* and *VOLCANO*.

The use to which certain explosions are applied is so well known as not to require any particular description. Every body knows the various uses of shooting with gunpowder, especially in military affairs. The blasting or breaking of rocks, by means of the explosion of gunpowder, is likewise well known. But these uses, together with all the particulars that relate to them, are often mentioned in various other articles of this Cyclopædia; such as *GUNNERY*, *MINING*, *SHOOTING*, &c.

**EXPOLITION**, in *Rhetoric*, a figure whereby we explain the same thing in different phrases and expressions, in order to shew it more fully.

Expolition was the favourite figure of Balzac.

**EXPONAS VENDITIONI**. See **VENDITIONI**.

**EXPONENT**, from *expono*, *I express*, in *Arithmetic*. Exponent of a power denotes the number which expresses the degree of the power, or which shews how often a given power is to be divided by its root before it be brought down to unity.

Thus, the exponent or index of a square number is 2; of a cube, 3; the square being a power of the second degree; the cube of a third, &c.

Exponents are commonly written above, and somewhat towards the right-hand of the number or quantity whose power they express. Thus,  $3^5$ ,  $a^5$ , signify the fifth power of 3, and of  $a$ . See **POWER**.

**EXPONENT** is also used in the same sense with index or logarithm.

Thus a series of numbers in arithmetical progression being placed under another series in geometrical progression, are called the exponents, indices, or logarithms thereof. *E. gr.* in the two progressions,

Geom. 1, 2, 4, 8, 16, 32, 64, 128, 256, 512

Arith. 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

0 is the exponent, index, or logarithm of the first term 1; 5 that of the sixth, 32, &c.

Hence, unity is to the exponent of a power as the logarithm of the root to the logarithm of its power; consequently, the logarithm of the power is had by multiplying the logarithm of the root by its exponent; and the logarithm of the root is had by dividing the logarithm of the power by its exponent.

**EXPONENT of a ratio**, is the quotient arising upon dividing the antecedent by the consequent.

Thus, in the ratio 3 to 2 the exponent is  $1\frac{1}{2}$ , and the exponent of the ratio 2 to 3 is  $\frac{2}{3}$ . See **RATIO**.

Hence, 1. If the consequent be unity, the antecedent is the exponent of the ratio. Thus, *e. gr.* the exponent of

the ratio 4 to 1 is 4; and again, the exponent of a ratio is to unity as the antecedent to the consequent.

2. Since in a rational ratio the exponent of a ratio is had by dividing a rational number by another rational, the exponent of a rational ratio is a rational number.

**EXPONENTIAL CALCULUS**, *Calculus exponentialis*, is a method of differencing exponential quantities, and of summing up the differences of exponentials. See **CALCULUS**.

**EXPONENTIAL curve** is that which is defined by an exponential equation.

Exponential curves partake both of the nature of algebraic and transcendental ones; of the former, because they consist of a finite number of terms, though those terms themselves are indeterminate; and of the latter, because they cannot be algebraically constructed, or represented by an algebraic equation. Thus  $ay = x^3$  is the equation of an algebraic curve;  $y = a^x$  is the equation of an exponential curve: this equation  $y = a^x$  denotes that any ordinate  $y$  is to a constant ordinate assumed equal to 1, as a constant quantity  $a$  raised to a power whose exponent expresses the ratio of the absciss  $x$  to the line equal to 1 is to the line taken for unit or 1, raised to the same exponent. Let  $b$  represent the line = 1, and the equation

$$y = a^x \text{ (since } y : b :: a^{\frac{x}{b}} : b^{\frac{x}{b}} \text{), will become } \frac{y}{b} =$$

$$\frac{a^{\frac{x}{b}}}{b^{\frac{x}{b}}}$$

Note,  $y = a^x$  is the equation of the logarithmic

curve. See **LOGARITHMIC**. See also **CURVE**.

**EXPONENTIAL equation**, is that wherein there is an exponential quantity. See **EQUATION**, &c.

**EXPONENTIAL quantity**, is a power whose exponent is an indeterminate or variable quantity.

Exponential quantities are of several degrees and orders: when the exponent is a simple indeterminate quantity, it is called an exponential of the first or lowest degree.

When the exponent itself is an exponential of the first degree, then the quantity is an exponential of the second degree. Thus,  $z^y$  is an exponential of the first degree, because the

quantity  $y$  is a simple flowing quantity; but  $z^y$  is an exponential quantity of the second degree; because  $y^x$  is an

exponential of the first degree; so also,  $z^y$  is an exponential

of the third degree, the exponent  $y^x$  being one of the second; and universally, the exponential quantity of any degree has for its exponent, the exponential quantity of the degree next preceding it. See Bernouilli Oper. tom. i. p. 182, &c.

**EXPORTATION**, in *Commerces*, the act of sending commodities out of one country into another.

Exportation is a part of foreign commerce (see **COMMERCE**), distinguished by the appellation *active*, or *selling part*, in opposition to *importation*, which is called the *passive*, or *buying part*. It is observed, as a general maxim, that commerce, when active, must produce a flow of riches, the balance being received in money; whereas, if it be passive, treasures will be exhausted, as the balance of trade must continually be made good out of the remaining coin. Hence, plenty of money in any place implies, that the quantity of goods exported far exceeds that of goods imported; and wherever money is scarce, it may be concluded that greater

quantities of goods have been imported than exported. See **EXCHANGE**.

It has been a principal object of commercial policy in almost every country, to encourage exportation, with the exception of a few articles; that of manufactured goods has been promoted with a view of encouraging the internal industry of the country, and that of foreign produce, as a means of drawing wealth from other countries by the profits of the carrying trade. The excess of the value of goods exported beyond that of the imports has usually been considered as a criterion of the profits which a country derives from foreign trade; but this is a fallacious mode of determining this important point, because advantageous foreign trade might long exist, even if the imports constantly exceeded the value of the exports. The laws in force relating to exportation consist principally of prohibitory or restrictive regulations concerning bullion, corn, wool, machinery, and tools used in various branches of the manufactures, the exportation of which, it is thought, might diminish the necessary supply of provisions for the consumption of the country, or enable foreigners to rival valuable branches of its manufactures. The acts relative to the exportation of wool, prohibit the exportation, not only of the commodity itself, but also of live sheep, rams, or lambs, from Great Britain, Ireland, Jersey, Guernsey, Alderney, Sark, or Man, on penalty of the forfeiture thereof, and of the ships conveying them; also 3*l.* for every sheep, &c. and three months' solitary imprisonment of the offender; for a second offence, 5*l.* for every sheep, &c. and six months' imprisonment; except wether sheep for ships' use, put on board by licence of the port-officer of the customs. A limited quantity of wool, however, is allowed to be exported from the port of Southampton to Jersey, Guernsey, Alderney, and Sark.

The duties on exportation, payable in Great Britain and Ireland, were formerly the principal branch of the revenue derived from foreign trade; but they are now of small amount compared with the duties payable on goods brought into the country.

The official value of all exports from Great Britain, for three years ending the 5th of January 1809, was as follows:

	British produce and manufactures.	Foreign merchandize.
Year ending 5th Jan. 1807	£. 27,402,685	£. 9,124,499
- - - 1808	25,171,422	9,395,149
- - - 1809	26,692,288	7,863,207

The actual value of British produce and manufactures exported from Great Britain, agreeably to the prices current, and to the declarations of the exporters, was, in the year ending the 5th of January 1809, £. 40,881,871.

The official value of imports into Great Britain from Europe, Africa, and America, during the same periods, is as follows:

Year ending 5th January 1807	£. 25,089,136
- - - 1808	25,453,149
- - - 1809	23,784,516

The official value of imports into Great Britain from East India and China is as follows:

Year ending 5th January 1807	£. 3,746,771
- - - 1808	3,401,509
- - - 1809	not ascertained.

The real value of Irish produce and manufactures exported from Ireland in the year ending the 5th of January 1809, computed at the average prices current, was £. 12,577,517.

108. *11d.* See CUSTOMS, and DUTY. See also COMMERCE.

Dr. Smith, in his "Nature and Causes of the Wealth of Nations," states and explains the principles upon which the exportation trade is founded. When the produce of any particular branch of industry exceeds what the demand of the country requires, the surplus must be sent abroad, and exchanged for something for which there is a demand at home. Without such exportation, a part of the productive labour of the country must cease, and the value of its annual produce diminish. The land and labour of Great Britain produce generally more corn, woollens, and hard ware, besides some other manufactures, than the demand of the home market requires. The surplus part of them must, therefore, be sent abroad, and exchanged in the manner already mentioned. It is only by means of such exportation, that this surplus can acquire a value sufficient to compensate the labour and expence of producing it. The neighbourhood of the sea-coast, and the banks of all navigable rivers, are advantageous situations for industry, only because they facilitate the exportation and exchange of such surplus produce for something else, which is more in demand there.

When the foreign goods, which are thus purchased with the surplus produce of domestic industry, exceed the demand of the home market, the surplus part of them must be sent abroad again, and exchanged for something more in demand at home. When the capital stock of any country is increased to such a degree that it cannot be wholly employed in supplying the consumption, and supporting the productive labour of that particular country, the surplus part of it naturally disgorges into the carrying trade, and is employed in performing the same office to other countries. The carrying trade is the natural effect, and symptom of great national wealth; but it does not seem, says Dr. Smith, to be the natural cause of it. Holland had formerly the greatest share of the carrying trade of Europe, and in proportion to the extent of its land, and the number of its inhabitants, it was the richest country in Europe. England, now the richest country of Europe, has appropriated to itself the greatest share of this trade. This ingenious writer suggests, that, whether the capital, which carries this surplus produce abroad, be a foreign or a domestic one, is of very little importance. If the society has not acquired sufficient capital both to cultivate all its lands, and to manufacture in the completest manner the whole of its rude produce, there is even a considerable advantage derived from the exporting of that rude produce by a foreign capital, in order that the whole stock of the society may be employed to more useful purposes.

Dr. Smith farther observes, in reference to this subject, that with a view of multiplying gold and silver, in which, it has been commonly supposed, the wealth of a country consists, it necessarily became the great object of political economy to diminish, as much as possible, the importation of foreign goods for home consumption, and to increase, as much as possible, the exportation of the produce of domestic industry: and, therefore, its two great engines for enriching the country have been restraints upon importation, and encouragement to exportation. The former were of two kinds, *viz.* restraints upon the importation of such foreign goods for home consumption as could be produced at home, from whatever country they were imported; and restraints upon the importations of goods of almost all kinds, from those particular countries, with which the balance of trade was supposed to be disadvantageous. These different restraints consisted sometimes in high duties, and sometimes in absolute prohibitions. Exportation was encouraged sometimes by drawbacks, sometimes by bounties, sometimes by advantageous

treaties of commerce, and sometimes by the establishment of colonies in distant countries. Thus it has been intended to increase the quantity of gold and silver in any country by turning the balance of trade in its favour. Our author has particularly examined what are likely to be the effects of these restraints and encouragements upon the annual produce of the industry of a country. According as they tend either to increase or diminish the value of this annual produce, they must evidently tend either to increase or diminish the real wealth and revenue of the country. See EXCHANGE, MONOPOLY, and *Balance of Trade*. Of the encouragements to exportation above enumerated, those which are called *Drawbacks* (see the article) seem to Dr. Smith to be the most reasonable. Concerning the grant of bounties; see BOUNTY.

EXPOSING, the act of setting a thing to public view.

In the Romish church, the sacrament is said to be exposed when it is shewn in public, uncovered, on festival days, and during the time of plenary indulgences.

EXPOSING is also used with a farther latitude; thus, we say it is prohibited to expose false and clipped money.

Such a house stands very high, and has a delicious prospect; but it is exposed to all the four winds. Such a city being on the frontiers, and not fortified, is exposed to the insults of every party of forces.

EXPOSING of *Children*, a barbarous custom practised by most of the ancients excepting the Thebans, who had an express law to the contrary, whereby it was made capital to expose children, ordaining at the same time that such as were not in a condition to educate them, should bring them to the magistrates, in order to be brought up at the public expence. (*Ælian Hist. Var. l. ii. c. 7.*) Among the other Greeks, when a child was born, it was laid on the ground; and if the father designed to educate his child, he immediately took it up; but if he forebore to do this, the child was carried away, and exposed. *Pitisc. Lex. Ant. in voc. Expositio.*

The Lacedæmonians, indeed, had a different custom; for with them all new-born children were brought before certain tryers, who were some of the gravest men in their own tribe, by whom the infants were carefully viewed; and if they were found lusty and well-favoured, they gave orders for their education, and allotted a certain proportion of land for their maintenance: but if weakly, or deformed, they ordered them to be cast into a deep cavern in the earth, near the mountain Taygetus, as thinking it neither for the good of the children themselves, nor for the public interest, that defective children should be brought up. Plutarch takes notice of this law of Lycurgus, and passes no censure upon it.

Many persons exposed their children only because they were not in a condition to educate them, having no intention that they should perish. It was the unhappy fate of daughters especially to be thus treated, as requiring more charges to educate and settle them in the world than sons.

The parents frequently tied jewels and rings to the children they exposed, or any other thing whereby they might afterwards discover them, if Providence took care of their safety. Another design, in adorning these infants, was either to encourage such as found them to nourish and educate them, if alive; or to give them human burial, if dead.

The places where it was usual to expose children were such as people frequented most. This was done in order that they might be found, and taken up by compassionate persons who were in circumstances to be at the expence of their education. With this intention the Egyptians and

Romans chose the banks of rivers, and the Greeks the highways.

Dionysius Halicarn. (Antiq. Rom. l. ii.) informs us, that Romulus obliged the citizens to bring up all their male children, and the eldest of the females. They were allowed therefore to destroy all their female children but the eldest. And even with regard to their male children, if they were deformed or monstrous, he permitted the parents to expose them, after having shewn them to five of their nearest neighbours. In Cicero's third book of laws, (cap. 8.) there is a passage, from which it has been concluded, that the law of Romulus, with regard to the exposing and destroying of male children that were remarkably deformed, was confirmed by a constitution of the twelve tables. It appears, from a passage in Terence, that this inhuman custom of exposing and destroying children, especially females, was not uncommon even among parents of the best character. Sentiments of this kind were published with applause on the Roman theatre: and we learn from Seneca (de Ira, l. i. c. 15.) that so late as in his time, it was usual among the Romans to destroy weak and deformed children. "Portentosos fetus extinguimus: liberos quoque, si debiles monstrisque editi sunt, mergimus."

This unnatural practice was prescribed and approved even by the more eminent philosophers. Plato (Republ. l. v.) recommends it to be ordered by law that men or women, who are past the age of having strong children, should take care that their offspring, if they should have any, should not come to the birth, or see the light; or if that should happen, that they should expose them without nourishment. Aristotle (Politic. l. vii. c. 16.) expressly says, that it should be a law not to bring up or nourish any child that is weak or maimed; and that when the law of the country forbids to expose infants, it is necessary to limit the number of those who should be begotten; and if any one begets children above the number limited by the laws, he advises to procure abortion before the fetus has life and sense. The practice that has long prevailed among the Chinese, and that subsists among them even to this day, is well known.

**EXPOSITION**, the act of exposing. See **EXPOSING**.

**EXPOSITION** is likewise applied to the interpretation or explication of an author, or passage therein. See **EXEGETIS**.

**EXPOSITION of deeds**, in *Law*, shall be favourable, according to the apparent intent; and be reasonable, and equal, &c. Co. Litt. 313.

**EXPOSITION, expeditio**, in *Rhetoric*, is sometimes used for division. See **DIVISION**; and see also **EXERGASIA**.

**EXPOSITION**, in *Gardening*. See **EXPOSURE**.

**EXPOSITOR**, or **EXPOSITORY**, a title which some writers have given to a lesser kind of dictionaries or vocabularies, serving to expound or explain the meaning of the obscure or difficult words of a language.

It is also used in the same sense with commentary and paraphrase.

**EX POST FACTO**, in *Law*, denotes something done after another thing that was committed before. An estate granted may be made good by matter ex post facto, that was not so at first, by election, &c.

**EXPOSTULATION, EXPOSTULATIO**, in *Rhetoric*, a complaint addressed to a person from whom we have received some injury. It varies according to circumstances.

**EXPOSURE**, or **EXPOSITION**, in *Gardening*, the aspect or situation of a garden wall, building, or the like, with respect to the sun, wind, &c.

There are four regular kinds of exposures, *viz.* east, west, north, and south; but it must be observed that among gardeners these terms signify just the contrary to what they do among geographers.

The gardeners, in effect, do not give the names east, west, &c. to the places where the sun is, but to those whereon he shines; and they consider the manner wherein he shines, whether as to the whole garden, or some of its sides.

If they find, that the sun at his rising, and during the first half of the day, continues to shine on one side of a garden or wall, they call that an eastern exposure, or east wall, &c. and if the sun begin to shine later, or end sooner, it is not a proper eastern exposure.

For the same reason, they call the west the side the sun shines on the latter half of the day; *i. e.* from noon to night; and accordingly, the south, or southern exposure, is the place whereon he shines from about nine o'clock in the morning till night; or which, in the general, he shines longest on in the whole day; and the part he shines least on is the north, or southern exposure, at what hour soever it begin or end, being usually from eleven o'clock to one.

The eastern and southern exposures are, by common consent of all gardeners, the two principal, and have a considerable advantage above the rest. A west exposure is not much amiss; at least, it is better than a northern one, which is the worst of all: each has its inconveniences.

The eastern, commencing differently at different seasons of the year, and ending about noon, subjects the trees, &c. to the N.E. winds, which wither the leaves and new shoots, blow down the fruit, &c. beside that it has little benefit of rains, which come mostly from the west. Yet does the reverend Mr. Laurence judge the east better than the west-wall for all kinds of fruit; not that it has more hours of sun, or that there are any peculiar virtues in the eastern rays, but because the early rays of the sun do sooner take off the cold chilly dews of the night.

M. Gentil recommends the eastern exposure as best for all kinds of peaches; adding, that they ripen soonest, grow bigger, are better coloured, and of a finer taste, than in any other; but Mr. Carpenter restrains the rule to the early and middle sorts; for the backward, he rather chooses a southern, or south-east exposure, which is best for all late fruits, because the influence of the sun is strongest, and continues longest.

The western, accounted from half an hour past eleven till sun-set, is backwarder than an eastern one by eight or ten days; but it has this advantage, that it receives little damage from the frosts, which melt before the sun comes to shine upon the fruit, and fall off like dew, without doing any prejudice; so that it may bear apricots, peaches, pears, and plums; but it is incommoded with north west winds in the spring, as also with the autumnal winds, which blow down a great quantity of fruit.

According to Mr. Miller, the best aspect or exposure for walls in England is the point to the eastward of the south; because those will enjoy the benefit of the morning sun, and be less exposed to the west and south-west winds, which are very injurious to fruits in England, than those walls which are erected due south; the next best exposure is due south, and the next to that south-east, which is preferable to the south-west. Other walls, however, may be planted with fruit-trees that suit their several exposures.

The northern exposure is the least favourable of any in England, as having very little benefit from the sun even in the height of summer, therefore can be but of little use, whatever may have been advanced to the contrary. For although many sorts of fruit-trees will thrive and produce

fruit in such positions, yet such fruit can be of little worth, since they are deprived of the kindly warmth of the sun to correct their crude juices, and render them well tasted and wholesome. It is therefore to little purpose to plant fruit-trees against such walls, except it be for fruit intended for baking, &c. in which case the fire will ripen and render those juices wholesome which could not be performed while growing.

In such situations, morelli cherries for preserving may be planted, and white and red currants to come late, after those which were more exposed to the sun are gone; and if the soil be warm and dry, some sorts of summer pears will do tolerably well on such an exposure, and will continue longer in eating than if they were exposed to the sun. But winter pears should by no means be planted in such an aspect, as has been practised by many ignorant persons, if we find that the best south walls in some bad years are barely warm enough to ripen them. Duke cherries planted against walls exposed to the north will ripen much later in the season; and if the soil be warm, will be well flavoured, and continue a month later than others. Miller.

The southern exposure, accounted from about nine till four, is recommended for peaches, pears, grapes, and plums.

EXPRESS, something that is precise in formal terms, or for some particular design. I told him as much in express terms; he gave me a commission express; he had express orders; a courier was dispatched express.

We also say, somewhat abusively, to send an express, meaning a courier.

EXPRESS *Condition, Contract, Malice, and Warranty.* See the substantives.

EXPRESSED OILS, are such as are procured from bodies only by pressing; as the oils of olives, almonds, and the like. See OIL.

EXPRESSED *species.* See SPECIES.

EXPRESSION, in *Algebra*, denotes the value of a quantity expressed or represented under an algebraic form: thus, if  $x = \sqrt{a^2 + b^2}$ , and  $a$  and  $b$  are known, the value of  $x$  is known. See EQUATION.

EXPRESSION, in *Chemistry, Pharmacy, &c.* the act of expressing out, or extracting the juices of oils or plants, fruits, or other matters, by squeezing, wringing, or pressing them in a press. This is one of the three modes of obtaining them; the other two being *infusion* and *decodion*, which see. The hard fruits should be well bruised, and herbs moderately bruised, before expression. They are then to be inclosed in a hair or other bag, and pressed between wooden plates in the common screw press, till the juice ceases to run. The expression of oils is performed nearly in the same manner as that of juices, by means of iron plates, or the apparatus of an oil-mill, adapted to this purpose. The insipid oils of all unctuous seeds are obtained uninjured by this operation, if performed without the aid of heat, which, though it may promote the extraction of the oil, gives it an ungrateful flavour. The oils expressed from aromatic substances generally carry with them a portion of their essential oil.

EXPRESSION, in *Music*, is a quality by which a musician manifests his feeling, and executes with energy all the ideas with which he ought to impress the hearer, and all the sentiments which the composer intended to express. There is an expression in composition as well as in its execution, and it is by their concurrence that the most pleasing and agreeable effect results.

To give an expression to his works, a composer ought to seize and compare all the relations which can be found between the features of his object, and the productions of his

art; in a musical drama, he ought to know and feel the peculiar cast of all the characters, in order severally to exhibit them exactly as delineated by the poet; for as a good painter does not throw the same light on every figure, neither will the able musician give the same energy to all the sentiments, nor the same force to every figure, but will put each part in its true place, less to give it weight, individually, than to contribute to the effect of the whole.

After having well considered what a character has to say, he meditates how he shall say it; and here begins the application of the precepts of his art, which is to find the particular language in which the actor would wish to make himself understood.

Melody, harmony, movement, choice of instruments and voices, are the elements of the musical language; and melody, by its immediate connection with the grammatical and oratorical accent, is that which gives a character to all the rest. So that it is constantly from melody that the principal expression should be derived, as well in instrumental as vocal music.

What a composer therefore has to express by melody is tone of voice, with which the sentiments can best be rendered; and care should be taken not to mimic that of theatrical declamation, which is in itself only an imitation, but the voice of nature speaking without affectation and without art.

The composer will therefore at first seek a kind of melody which shall furnish musical inflections the most consonant to the sense of the words, always lowering their expression to the thought, and the thought to the interlocutor's state of mind; for when we are strongly affected, all that we say in a manner favours of the general sentiments which govern us; and we never chide what we love in the same tones as we should an indifferent person. Our speech is differently accented according to the different passions by which we are agitated; sometimes acute and vehement, sometimes languid and monotonous, sometimes varied and imperious, sometimes smooth and tranquil in its inflections. Thence the musician regulates the choice of keys which he uses in his melody, and the different places in which he employs voice, keeping it down with small intervals to express the languor of sorrow and dejection; and straining it with acute sounds in passion and grief; driving it rapidly through all the intervals of the diapason in the agitation of despair, or the turbulence of distracted passions. Above all it must be remembered, that the charms of music consist not only in imitation, but in an agreeable imitation; and that the declamation (or recitative) itself to have its full effect, should be subordinate to melody; so that there is no painting sentiment without giving it this secret charm inseparable from it, nor touch the heart without pleasing the ear. And this is still very conformable to nature, which gives to the tone of voice of persons of sensibility, certain touching and delicious inflections, which those who feel nothing never possessed. Never, therefore, mistake rough and coarse for expressive, nor harshness for energy. Give not a hideous picture of the passion which you wish to paint, nor imitate the performers at the French opera, where the voice of passion resembles a complaint of the colic, more than transports of love.

The natural pleasure which results from harmony, augments in its turn the moral pleasure of imitation, in uniting the agreeable sensations of chords to the expression of the melody, upon the same principle as that just mentioned. But harmony does still more; it enforces even the expression in giving more truth and precision to melodious intervals; it animates their character, and exactly marks their place in the order of the modulation; it calls back the preceding, announces

## EXPRESSION.

announces that which ought to follow, and thus connects the phrases in the melody, as ideas are linked together by grammar in a discourse. - Harmony, regarded in this light, furnishes the composer with powerful means of expression, which escape him when he seeks expression in harmony alone; for then, instead of animating the accent, he extinguishes it by his chords, and all the intervals, confounded in a continued crowd of combined sounds, offer to the ear only a series of fundamental chords, which have nothing touching or agreeable in their effect, and often not only suffocate the melody, but the sense of the words. - What then must the harmonist do to fortify the expression of the melody, and give it more effect? He will carefully avoid covering the principal sound in the combination of chords; he will render all the notes of the accompaniment subordinate to the vocal part; he will give relief and energy to it by the concurrence of other parts; he will enforce the effect of certain passages, by the chord of the sharp 7th; he will disguise others by supposition or suspension, in making no provision for them in the base; he will gain strong expressions by major discords, he will reserve the minor, for tender sentiments; sometimes he will unite all his parts by smooth and flowing notes; sometimes he will contrast them with the melody by pointed notes; sometimes he will fill the ear with full harmony, and sometimes enforce the accent by the choice of a single interval. He will render present and sensible the chain of modulation throughout, and will make the base and its harmony serve to determine the place of each passage in the key, in order that no interval or trait of melody shall be heard, without feeling at the same time its relation with the whole.

With respect to rhythm, formerly so powerful as to give force, variety, and ornament to poetical harmony; if modern languages less accentuated and less prosodic have lost this charm, our music can substitute another more independent of speech in the precision of measure, and in the combination of its proportions, whether moving together or separately in each part.

Quantity in language is almost wholly lost in notes of music; and the music, instead of speaking with words, borrows, in some sort, from the measure a language apart.

The force of the expression consists in this particular, in the uniting these two languages as much as possible together, in such sort, that if the measure and the rhythm speak not in the same manner, they will at least say the same things.

Chearfulness, which gives vivacity to all our movements, ought to do the same in musical measures. Melancholy locks up the heart, relaxes all our motions, and the same languor is felt in the melodies which it dictates; but when grief is poignant, or great conflicts are passing in the mind, speech is unequal; it moves alternately with the slowness of the spondee and the rapidity of the Pyrrhic, and sometimes suddenly stops short, as in accompanied recitative; it is on this account, that the most expressive music, or at least the most passionate, is commonly that in which the times or portions of each bar, though equal in themselves, are the most unequally divided; whereas the image of sleep, of repose, of peace of mind, require small exertion of voice, and are naturally painted with notes of equal length, which move neither quick nor slow.

There is one observation which the composer ought not to neglect, and which is, that the more studied and extraneous is the harmony, the slower should be the movement, in order that the mind may have leisure to disentangle the discords, and follow the rapid chain of modulation. Nothing but the last degree of fury can permit the union of rapid measures and harsh chords. When the head is

distracted, and the actor, by violent agitation, seems not to know what he says, this energetic and terrible confusion may be communicated to the mind of the spectator, and, in like manner, make him lose his reason. But if the composer is not inflamed and sublime, he will only be coarse and cold; if he does not throw the audience into a delirium, he runs a great risk of a failure: for he who loses his reason is only mad in the eyes of those who preserve it, and insanity is no longer interesting.

Though the greatest force of expression is derived from the combination of sounds, the quality of their tone is not indifferent in the effect. There are voices so strong and sonorous as to impose by their force; others thin, flexible, and fit for execution; others again so touching and delicate as to penetrate the heart by soothing and pathetic strains. In general, treble voices and acute are fittest to express tenderness and affection; bases and baritones for intemperate passion and choler; but the Italians have banished bases from their serious operas, as a part, of which the melody is too rude and boisterous for the heroic style, and have substituted in their stead tenors, of which the melody has the same character, with a more agreeable effect. They employ base voices in the grotesque and ridiculous parts of their comic operas with more propriety.

Instruments have also their peculiar expressions, proportioned to their quality of tone, force, and compass. The flute is tender, the hautbois cheerful, the trumpet military, the horn sonorous, majestic, and proper for grand expressions. But there is no instrument of more varied expression, and more universally useful, than the violin. This admirable instrument is the foundation of every orchestra, and can furnish a great composer with all the effects which mean musicians vainly seek in a multitude of different instruments. The composer ought to be acquainted with the finger-board of the violin, to consider the shifts, and know how to write arpeggios, by distinguishing the open from the stopped strings, and to choose and make use of keys according to the different characters they have upon that instrument.

It is in vain for the composer to attempt to animate his orchestra, if the ardour which ought to reign in it does not inflame the performers. The singer who only sees notes in his part, is not qualified to seize the expression of the composer, nor to give one of his own to what he sings, if he has not well comprehended the sense. He must understand what he reads before he can make it comprehended by others; and it is not enough to be possessed of general sensibility, if not particularly energetic in the language we speak. Let him begin therefore by thoroughly understanding the character of the melody which he has to execute, its expression of the words, the distinction of its phrases, the accent which it has in itself, that which it requires in the voice of the singer, the energy which the composer has given to the poet, and that which in his turn he can give to the composer. Let him resign his whole powers, then, to all the enthusiasm which these considerations shall have inspired; he should express every thing as completely as if he were at once the poet, composer, actor, and singer, and he will then have all the animation which it is possible for him to give to the work which he has to execute.

In this manner he will naturally embellish with taste and delicacy airs that are only elegant and graceful; with spirit and fire, such as are animated and gay; with sighs, the tender and pathetic; and with all the agitation of forte and piano, such as are expressive of rage and fury. Whenever the musical and oratorical accents are united (as in arie parlanti), wherever the time shall be strongly marked, and serve as a guide to the accents of the melody; wherever the accompaniment

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companionment and the voice shall so agree in their effects as to form only one melody, and the hearer, deceived, wholly attributes to the voice the passages which the orchestra embellishes; and, finally, wherever lober ornaments, judiciously applied, manifest the abilities and facility of the singer, without disguising and injuring the melody, the expression will be sweet, agreeable, and animated; the ear will be delighted, and the heart affected; nature and art will at once concur in pleasing the hearer, and there will reign such a coincidence between the words and the music, that the whole will seem to proceed from one delicious language, which can say every thing, and always please.

This is more a dissertation than an article of a dictionary, but these are the sentiments of the citizen of Geneva, to most of which in music we readily subscribe, as he is ever more reasonable and consistent in speaking of that art than on any other subject. His views concerning dramatic music are always so ingenious, elevated, and refined, that we cannot resist translating him. Though we fear that the French, with all their present rage for Italian music and Italian expression, will not adopt them; and the Italians themselves, in their most happy moments of conception, have been successful from instinct and enthusiasm, more than precepts or reflection.

EXPRESSION, in *Oratory*, denotes the manner of delivering or conveying one man's ideas to another. Accordingly it denotes that felicity of discriminative energy in the reader, speaker, or reciter, by which the characteristic beauties or peculiarities, whether of language, sentiment, or passion, in a composition or oration, are forcibly and happily illustrated; and the various shades and transitions of style, signification, feeling, and allusion, in such composition or oration, are distinctly and interestingly marked. Expression in this, as in every other art, is one of the chief constituents of excellence; and contradistinguishes the elocutionist of taste and genius, from the mere mechanical reader or declaimer. It depends chiefly upon that quickness and vitality of perception which may be regarded, in some degree, as an original gift of nature, and on that prompt and perfect sympathy between the perceptive faculty and the executive organs, which it is the highest glory of art and practical exercise to produce.

EXPRESSION is more particularly used for the elocution, diction, and choice of words in a discourse. See ELOCUTION.

It is not enough that a poet or orator have fine thoughts, he must likewise have a happy expression. Defects in the expression ordinarily arise from defects in the imagination: abundance of the beauties of the ancient writers are annexed either to expressions which are peculiar to their language, or to relations, which, not being so familiar to us as to them, do not give us the same pleasure.

EXPRESSION, *diversifying of*, in *Rhetoric*. See DIVERSIFYING.

EXPRESSION, in *Painting*, principally consists in the representation of those attitudes of the body, and variations of the countenance of men, which always accompany and denote the immediate influence of the passions of their minds. Besides this more important use of the word, it is used in painting to signify the representation of any object by a mode of execution agreeable to its nature, its character, and the situation it holds in the work. When wrought with just sense and propriety in these respects, it is said to be *well expressed*. We will first consider it in the former and more useful sense.

The passions which influence the conduct of men have each a general character of expression, by look or gesture,

attached to them in the whole race of mankind; and they are also marked in individuals by peculiarities, arising from the temperament and constitutional habits with which each of them is endowed by nature.

To seize and represent with energy these characteristics of the passions of the mind, and accompany their representation without diminishing its force, with the varieties appropriate to the individual personages introduced into a picture, is the essence, the soul of art. The slightest sketch possessing this quality, acquires an interest unimpaired by, and far above, that excited by the most highly and excellently wrought pictures which are void of it.

Very few painters, amongst the immense numbers of those who lay claim to the name, have been happy enough to obtain a super-eminent degree of expression in their works; indeed it is a task of extreme difficulty to overcome, requiring the soundest sense to select the knowledge of it, and the greatest ability in art to represent it when understood. The man who aims at it, besides being an ever active observer, should possess great susceptibility of mind to enter into the feelings of others, and thus draw, as it were, from himself: yet that susceptibility should be under the regulation of sound discernment, and cool dispassionate judgment, to enable him to discriminate the fictitious representations of passion, from those natural unartificial actions, and looks, dictated by, and arising from, genuine feeling; and in his continued observations upon the actions and aspects of men under their influence, he should be careful to separate those points which identify a peculiar passion, and distinguish it from others that are nearly allied to it.

Artists endowed with very considerable talents have failed in two different ways in their endeavours to embellish their works with this valuable quality. Some, by an over-anxious desire to give strength and energy to their expressions, have carried them into artifice and bombast: others, on the contrary, wishing to unite the beautiful with the pathetic, have only rendered their works insipid and uninteresting in expression; and it appears that he who is obliged to labour to produce it, who does not work from a clear comprehension of the characteristic lines of an expression in its simplest and most undisguised shape, can never effect the representation of it to any degree of perfection, and the beholder of his works will still leave them unimpressed with any portion of the sensation the real passion is calculated to produce; the only true test of the value of works of art, as far as relates to expression.

“By tedious toil no passions are express’d,  
He who conceives them strongest paints them best.”

The power of rendering, or producing expression in painting, is, next to grace and elegance, the least communicable talent of those requisite to form a perfect painter. He who attempts to obtain it, if not originally gifted by the great Author of nature with a peculiar propensity to observe and imbibe the leading features which constitute its excellencies, follows a phantom that will for ever elude his grasp. If, however, he happily possesses that inclination, he may obtain some assistance in his pursuit of it from the works of others, which will shorten his labour; but will not lead him to the ultimate point of his desire; to that, the study of nature can alone effectively induce.

We allude to some general rules given by artists who have communicated the result of observations made in their endeavours to obtain an understanding of the expression of the passions of the mind, in the countenances and actions of men; and they are by some, whose names authorize reliance upon their observations, particularly Lionardo da Vinci,

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Trattata de la Pittura, and Le Brun's Passions. They have pointed out and illustrated those actions of the countenance and figure which most strongly designate the reigning influence of particular passions.

These rules, however, go only a short way in a general view of the subject; much less do they comprize what is requisite, when the multitudinous varieties of expression in the almost infinitely varying countenances and habits of men of all degrees are taken into consideration. How, indeed, can it be possible to direct the means of obtaining with certainty that which is in itself so infinitely divisible, as the course of the feelings and dictates of the ungovernable heart of man, and his corresponding actions and turns of feature?

It is in having ascertained and established the features of the more strong and leading passions, that these general rules are found useful. We learn from them, that the influence of excessive joy or laughter draws all the features of the face upwards; that grief reverses that order, and draws them downwards. Violent anger distorts them, and enlarges their appearance, particularly the eyes and nostrils; and the action of the body is violent, with quick and short motions. Desire enforces an eager advancing action towards its object, and the eyes and mouth are somewhat expanded. Acute pain is generally expressed by a mouth somewhat opened and drawn back, the eyes raised, and partly covered by the upper eye-lid; and the eye-brows drawn closely together, wrinkling the forehead. Fear is denoted by expanded eyes and mouth, the eye fixed upon the exciting cause, the hair elevated and thickened, the colour livid, and the figure drawn back as if attempting to retire from the object which causes the alarm. The effects of the sensation of scorn or hatred on the figure and countenance are marked by the mouth being closed firmly, and the lips drawn down at the corners; whilst the elevation of the nostril causes the middle of the upper lip to rise; the forehead is strongly pressed, and the brow falls over the eyes, which express the passion best when they are turned sideways, towards the object, with the body inverted from it. Awe, or veneration, produces a general inclination of the body, and the head still more so, towards the object exciting it.

Under one or other of these passions and expressions all the feelings of our minds are more or less ranged; and of course will participate more or less of the indications of them, according to the excitation they meet with: therefore, so far the general rules will be of use in their representation. But mankind, from their various modes of education, their habits, and manners, accompany these sensations, when excited in them, by peculiarities which it is of the utmost importance to the painter justly to discriminate, and be careful not to give that action to one, which, in propriety, belongs to another; not to attach the vulgar action of an uncultivated clown, to the dignified character of a man of rank and liberal education.

Besides remarking the expressive characters of the stronger passions, great attention is requisite to be paid to the physiognomical expression of the countenance, and of the figure (if one may so speak); the influence of which is daily felt and acknowledged. Though our information upon that subject is much thwarted by the effect of education and reflection, yet its basis is just and firmly fixed, as every day's experience proves. Persons whose features and general forms correspond, are found to be correspondent also in character; that is, in their natural propensities: one of two, thus similarly formed, may have cultivated his mind more than the other, and education and society may have taught him to mask or disguise his inclinations; but nature is still true to herself, and the same general disposition re-

mains. Nay, it goes still further; young persons not naturally addicted to vice, being drawn by accident or early association to continue in the practice of indulgence, acquire, in process of time, a change of feature and expression, in great measure similar to that form usually indicative of the vice or passion indulged in, where it is implanted by nature.

In this, therefore, we have a ground of expression which is well worthy, indeed very necessary, to be carefully attended to by those who aim at perfection in the art of painting. They ought to make themselves acquainted with the forms that belong to the peculiar inclinations and different degrees of capacity of mind in the persons they chuse to bring forward in their works, of whatever class they may be. They should not put into the face of a man of mild character any of the features indicative of warm passions; in such an one the eye should not have an eager look; the nostrils should not be large, or inflated; all the lines should be smooth, and have little variation of form. And, on the contrary, when the figure of one whose disposition is naturally hot and impetuous is introduced, he should not have a smooth straight forehead; which is indicative of mildness and suavity; his nose should not be straight; nor his mouth gently undulating, of a mild pleasing character: though he may not be in the act of exerting his natural impetuosity of character, yet he should have the appearance of one who would be easily roused to that feeling and expression. A man of great sense and intellect should not be represented with the features that characterize imbecility; nor the weak, and undecided character, have the forms denoting sense and intellectual power; and it should be constantly remembered, that though every passion, every sentiment of the mind, has its peculiar expression; every particular person has his peculiar mode of expressing it.

In representations of the passions, 'tis not form alone which is required to perfect the work: though that indeed yields a very strong impression of it, yet its effect is greatly heightened when a proper tone of colour is superadded. By colour we judge of health or sickness, of youth and age, as well as by form: The fallow hue of melancholy is proverbial. It is well known how anger affects the hue of the countenance; in some it produces a violent flush of blood, and consequent redness of colour, even almost to blackness: in others a pallid hue denotes it, or a change from one to the other rapidly succeeding. The malignant passions are generally accompanied in their expressions by a pallid tone of colour: and the more noble sentiments by the reverse. A man performing a benevolent action feels a degree of satisfaction which affects his countenance; his eyes exhibit his sentiments by their liveliness, and his mouth by its gentle curves at the corners, whilst his cheeks bear (what is perfectly understood so as to be admitted a common phrase) the cheerful glow of humanity stamp on them. Clearness of complexion, and colour in the cheeks, indicate youth and health; fallowness, and the loss of the ruddy hue of colour, sickness and age. The inhabitants of the town, and of the country, exhibit the same distinctions; as also the studious man and the sportsman. Independent of the individual hue of the character represented, one general tone over the whole picture should prevail, correspondent to the subject. Thus, if it be one of a grave cast, the tone of colours should be low, yet rich; and though harmonious not monotonous. If, on the contrary, the subject is gay, the hues of the colouring should be bright and cheerful, and greatly diversified; and every part of the picture should assist in expressing the nature of the subject chosen for representation.

It is attention to this point which gives to painting its real value, its intrinsic worth; and separates it from the

more vulgar or merely mechanical arts. Hence it becomes of moral utility, and its power is not surpassed by the poetic, or other effusions of the pen, in the force and vivacity of the impressions it is calculated to produce. Of this there are many notices given to us in history. Alexander is said to have trembled and grown pale on seeing a picture of Palamedes betrayed to death by his friends: it bringing to mind the remembrance of his treachery to Artilonicus. It is also related of an Athenian courtesan, that in the midst of a riotous banquet, calling her eye on the portrait of a philosopher marked with the happy character of virtue and temperance; she was struck with so lively an image of her own unworthiness, that she instantly went home and became an example of temperance. In both these cases, to the truth of the expression must be ascribed the force with which the pictures wrought upon the observers; and produced the powerful impulse related.

It appears, indeed, to have been the principal object of attention with the ancient Greeks, and very naturally so; for in the beginning of an art, before any rules for regulating its efforts were adopted the artist's attention must of course have been solely directed to relating his story; and whatever assisted in effecting that, was pressed into the service. First of all, we are told, the efforts were so rude it was necessary to explain them: afterwards labels were placed as issuing from the mouths of figures; and other means of giving the ideas, supposed to occupy their minds, were adopted, till at last the artists arrived at the perfection of imitations of nature; and by giving their figures the actions and expressions appropriate to their situations, caused them to tell their own story, and impress all its interest on the beholders, without any extraneous aid. Unhappily, excepting the few pictures found at Herculaneum, and those are of a trivial kind, we have none of their works in this art to judge of the degree of perfection they arrived at in this most important point of it; but we have the testimony of many authors, some of whom speak as eye-witnesses, by whom we are led to believe, on convincing grounds, that their best pictures were full fraught with this best of good qualities; and there is no reason to doubt the truth of the report, when we see the sculpture of the same period which remains to us, so rich in possession of it.

In their statues, which were principally of gods, a great degree of minutiae of expression does not appear to have been the object of their attention, as far as relates to the passions, the representation of which they seem properly to have regarded as degrading to the dignity of a divinity. A calm untroubled state of mind appears in their countenances, and governs their looks and actions, but each has its appropriate character. What can be more dignified and majestic than the countenance of the Jupiter? Yet the line which its air, partaking somewhat of severity, inspires, is so blended with mildness, that it produces implicit confidence and veneration. The Apollo Belvedere has also the dignity of the godhead shining in it; but less imposing and overpowering, of a milder character, and the expression of his figure and action is perfect; no one doubts the intent of it for an instant; and this just discernment, and impress of character, run through the whole class of statues of the primary deities of the Greeks. The Venus, the Bacchus, the Hercules, &c. have each their distinctive line of character without passion, whose influence they are supposed to be exalted above, whilst in the lower orders, the fauns and nymphs, and rural deities, are no less properly marked with characteristic features and actions. In the figure of Laocoon destroyed with his sons by serpents, the authors (who were three) have exhibited a most powerful extent of feel-

ing and power in expression, remaining almost unrivalled in subsequent productions; the agony of pain and distress of mind are spread over the whole work which chills the beholder with horror.

Correspondent with this powerful effect is that related of and attributed to their pictures. Pliny says of Aristides, "that he infused into his pictures all the passions of the soul." It is said, "that Parrhasius, in his picture of Philoctetes, had renewed the pains of the hero, as seen in his parched deep sunk eyes, and the tears which flowed from them;" (Anthol. lib. 4.) and the epigrammatist concludes with a handsome compliment to the painter, blaming him "for not allowing the sufferings of Philoctetes to end with his life." Philostratus, Vita Apollonii. cap. 10. says, speaking of the Ajax of Timotheus, "we cannot do justice to the picture where Ajax is represented distracted, unless we previously form in our minds the image of his condition. The picture of "Medea contemplating the Murder of her Children," by the same painter, was the subject of numerous epigrams (Anthologia); so that it must have been very powerful to excite so much emulation among the wits to celebrate it. It was said to represent in her face, fury mixed with pity of the innocence of her children, who were represented smiling at the dagger in her hand. Ovid says, "her crime was confessed in her eyes." Plutarch says of Lyfippus the painter, that he was ingenious as well as sublime; that from the slight inclination of the neck natural to Alexander, he invented a sublime expression; making him look up to the heavens with manly boldness, and commanding majesty. The same author (in Timoleon) praises the paintings of Nicomachus "for their just expression," comparing them "to the poetry of Homer in grace and facility;" and Apelles in this point affirmed himself superior to other painters, though inferior in some others of less importance. It is needless to repeat the well known story of Timanthe's picture of the Sacrifice of Iphigenia, and of his artifice in hiding the face of the father, having exhausted the force of expression in the beholders; commendations and imitations of it are met with every where; and of his ingenious contrivance to convey an idea of the immense size of a Cyclops, by drawing some Satyrs measuring his figure with a thyrsus; and Pliny remarks of him on this occasion, that "in all his works there is more understood than is marked, and though his execution be matterly, yet his ideas exceed it."

Whatever allowance be made for the zeal and strength of terms with which persons at all times describe those things, than which they are unacquainted with any thing better, and which must have been the case in the early periods of art, the writers not being so learned in it as the painters who made it their continual study; yet we cannot refuse belief to a wonderful extent of power in rendering expression among the Greek painters, accompanied, as (it has been before observed) these descriptions of it are, by the actual effect in sculpture. It is more astonishing that it should ever have been lost sight of; yet that was the case, and on the revival of the art of painting the old original futile means of labels, &c. were had recourse to, till the gradual advance of learning and propriety of sentiment again restored it in the 15th century to the just imitation of the impressions of nature. Massaccio was among the first who thus advanced it, but it was Lionardo da Vinci who first perfected its claim to interest over the mind, though, perhaps, in none of his works so completely as in his representation of the Last Supper, painted on the walls of the refectory of the Dominican convent at Milan, where it shone for a period, unrivalled in truth and vigour of expression.

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It represents the moment wherein our Saviour has just said to his disciples "One of you shall betray me." Each figure has intelligence beaming from it; each individual exhibits a full report of what passes within his bosom. How tranquilly, yet how fully does our Lord disclose this forerunner of his approaching miseries, that one of those whom he had loved and cherished should become treacherous, and turn his bounty to his ruin; and with what propriety is he thus represented tranquil, yet dignified! so consistent with his high character and office! With what eagerness does the impetuous Peter apply to the well designated meek and humble John, to learn the name of the culprit that would betray so good a master! while that conscious culprit, hearing the request, starts backward with alarm, fearing the consequences of such a disclosure. These are representations so powerful, that it needs but the regard of a moment to comprehend all said, and to be said, to complete the whole interest of the story. The timid hesitating Thomas, at a small distance from Peter, presses his hand on the other's shoulder, to urge him to make the request his own timidity prevents him from doing himself. The next of the apostles, whose peculiarities history hath not so fully recorded, are represented in great variety of actions and expressions corresponding with, and justly originating in, the incredible circumstance just announced to them. One, with his hands pressed on his bosom, rising, asserts his innocence; another starts with surprise, and, in the pious consciousness of sinful weakness, seems to demand "Lord, is it I?" One calmly, yet earnestly, listens to the result of the question urged by Peter: others, in contrast with him, seem to argue together if it be possible such iniquity could dwell with man, and in so doing declare their own innocence. Anxiety is depicted as disturbing every breast, yet the peculiarities of each are preserved with the most just discrimination; and all appear so impressed with nature, that while it is recognized as the offspring of that great man's genius, the mere imagination of his mind, it has the appearance of a portrait of the actual scene. It is now unfortunately much injured by time and cleaning, being painted in oil, and not, therefore, adhering to the wall so perfectly as fresco.

To become able to produce a work of this surprising power in expression, Lionardo says of himself, that he lost no opportunity which the occasions of life afforded him, of storing up remarks upon the nature of its action in men. He paid much attention to anatomy, and is said to have attended executions, not only to watch the looks and actions of the sufferers, but also to observe how the different persons composing the crowds of spectators were affected. The common occurrences of life are every day affording the attentive and ingenious artist lessons on this head; and he will succeed, accordingly as he is intelligent and active in observation of them; or if he neglects to improve his mind by them, is inattentive and unfeeling to them, he can never become equal to the task of representing them.

Michael Angelo was also a powerful promoter of this high quality in works of art, but his expression is of a grand and more mystic nature than Lionardo's, and it is Raffaele alone that has approached in his own way the superior excellencies of the work we have above described. "We stand in awe of Michael Angelo," says M. Fuseli, "while we embrace Raffaele, and follow him wherever he leads us." He has not succeeded well where he has attempted the sublime. His gods are not even heroes, and his heroes are common vulgar men, except in a few instances; but where tenderness, and the amiable qualities of human nature have been his subject, he is not behind his great

forerunner. Nor in the relation of his story is he ever deficient; sometimes, indeed, as has been observed on the Cartoon of Ananias struck dead, under the word ENERGY, in *Painting*, he combines the past events on which it depends, and the future, to which it leads. His Cartoons of "St. Paul preaching at Athens;" the "Healing the Lame Man at Lystra;" "Elymas struck blind," are instinct with feeling and expression: they are but slightly finished, and lack the extreme perfection of Lionardo's work; however, from the high degree of character to which Raffaele has carried some of his heads, in his picture of the "Transfiguration," 'tis fair to suppose he could have perfected these, if the nature of the works (being only examples for tapestry) had required it. In comparing the reputation of Raffaele to Lionardo da Vinci in this respect, it should not be forgot that he was only 36 years old when he died, and the latter was 49 or 50 when he painted the astonishing work of the "Last Supper." Had Raffaele lived to an advanced age, it is probable he would have surpassed even him. The simplicity and fullness with which he describes, or effects, the relation of his subject, is beautifully instanced in the Cartoons of "St. Paul and Barnabas healing the lame Man at Lystra," and the consequent adoration paid to them. The apostles are raised upon some steps above the croud, and thus distinguished, as well as by the attention of all being directed to them. The restored cripple is known from the rest, by his eager demonstrations of gratitude and adoration; by his united and uplifted hands and animated looks, addressed to his restorers, and by the crutches now become useless, and fallen at his feet to the ground. An aged man bending forwards, lifts with one hand the garments of the healed man, to view the limb now become perfect, and simply by the uplifting of the other, expresses his admiration of the cure so miraculously effected. It is the simplicity of the means Raffaele uses, which gives so much the appearance of nature to his expressions: no one, on seeing the works, doubts but that he should have employed the same means; the art is lost sight of. The effect of the pictures of Raffaele, in point of expression, on the artist who observes them, is much the same as Garrick's acting the character of a clown is said to have had upon a countryman, who completely lost sight of the actor, and criticized only the sentiments, in which, by the by, he complimented the author also, by stating that he should have done the same himself. Yet it is a fact, that no point in art is so difficult to attain as this true simplicity of character with effect. Perhaps the most beautiful piece of expression in painting known to the world, is Raffaele's head of the Madonna della Sedia, now in Paris. The sweetness of sentiment conveyed by the mouth is completely undefinable: no picture has been so frequently copied, none so rarely imitated.

Titian has frequently succeeded in rendering expression in his works, though it is not his general characteristic. His picture of St. Peter Martyr, before alluded to, (see EXECUTION, in *Painting*,) is almost perfect in this, as well as in most other points. Indeed, when taken in the whole, we cannot help considering this as the most perfect picture in the world; possessing more of every good quality than any other we are acquainted with. It has strongly the character of expression, both in form, and correspondent tone of colour. No man of feeling regards it, but with an instantaneous sentiment of seriousness; somewhat, indeed, of horror is inspired by the first view of it; particularly by the figure of the monk who is running away, and who eyes the proffered palm of martyrdom itself with horror. In direct opposition to him is the figure of the saint; who, suffering under the power of the

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the assassin, (in whose person nought but the sentiment of brutality prevails,) turns his eyes towards the angels descending with the palm and crown, and hails the vision of future glory. The hue of the picture, we have said, is serious, and it is also rich and deep in colour; 'tis the effect of that hue which prevails at twilight, and is most judiciously chosen as suitable to the affecting nature of the subject. Raffaele has employed it in his portrait of Leo X. with the cardinals Rossi and Medici attending him. Here the subject was grand, and its effect is increased by the deep and serious tone of the colouring.

Poussin has, in several instances, been very happy in the expression of his subject. One of his pictures we will mention as a very excellent model of it; 'tis the Judgment of Solomon, a picture bad in its colour, in its composition, and execution, but fraught with the quality we are now considering. The king is seated upon his throne, surrounded by his attendants, and has just given the command to divide the living child. A soldier is proceeding to execute the order, and this gives occasion to the admirable display of diversity of feeling in the by-standers. An old man seems coolly to reason with himself if the king can intend the performance of so cruel a sentence. Another looks earnestly forward with the vacuity of aspect so commonly produced by surprise. A woman turns away her head to avoid the sight, and her child clings to her side alarmed. A soldier regards the scene with a countenance fraught with pity, another turns from it with disgust. Whilst the wicked, abandoned woman, who had slain her own child, seeks the destruction of her neighbour's also; the real mother implores, with an earnestness never to be too much admired, the preservation of her child; rather willing to disown, than to see it destroyed. The expression of the action of the king is completely that of conviction to whom the child belongs; he almost seems to exclaim, now I see the right, now I know to whom to give the award. Poussin has also in this instance added another useful indication of character in the attire of the woman, no less different in mind, than in habit. He has given to the vicious creature that negligence in dress which is too often indicative of a general habit of idleness and neglect; whilst he has dressed the other with decent care, and propriety.

This great painter has in another picture exhibited the force of colour in rendering expression, almost independent of form: 'tis in his picture of the deluge; one of a series of four pictures meant to represent the four seasons of the year. It is almost entirely of one hue. The composition consists of little more than a large portion of sky and water; the latter in the lower part of the picture falling in a cataract. In the distance is the ark, scarcely discernible through the thickness or dullness of vapour, through which the sun is with difficulty also seen, of a reddish hue. In the lowest corner of the picture is a family, consisting of a man, his wife, and child, endeavouring to climb from a boat upon a rock, on which a serpent glides along; and a little farther towards the centre are seen the heads of a man and horse just sinking in the water. With these slight materials has Poussin wrought a picture which is completely overpowering in its melancholy effect. It is said that Rousseau would sit enrapt in silence over it for hours, gratified with the sensations it inspired.

Another master, whose attempts to render expressions have been sometimes very successful, is Guido Rheni; but he seldom goes farther than the characters of saints in pious ejaculations, Magdalens in the moment of contrition, and Ecce Homo. Of the latter, there is one of super-excellent perfection, in the possession of B. West, esq. a head only, but full of feeling; surely "never was sorrow like unto his

sorrow," may be as justly applied to the painting, as to the sufferings of the divine original. There is an ancient painting of a Satyr's head, now in the Barberini palace at Rome, which is eminently distinguished by expression of character.

There are but few among the large mass of the Italian and French painters who have succeeded in their efforts (to any pre-eminent degree) in giving expression to their works in its more exalted sense. Ludovico Carrache, and Domenichino have sometimes effected it, but rarely, and Annibal Carrache still less frequently, notwithstanding his immense power in execution. Among the Flemings, Jan Steen, and Ostade, hold the principal places. The former particularly is exceedingly happy in characterizing the aspects and manners of that class of men he undertook to paint, and he does it with great freedom and ease. Ostade is more laboured in his manner, but perfect in his finish in the confused scale in which he exerted himself. Rubens has sometimes succeeded to a high degree in this quality, but, in general, the expressions of his figures in serious subjects are too violent, and outstep the modesty of nature. In the gayer scenes, where nymphs and fawns are fancifully indulging their humours, his power is complete; they live and breathe with all their native gaiety and animation; and in expressing the characters of beasts, either calm or enraged, not even Snyder has surpassed him. Vandyke rarely appears to have felt it in his historical pictures; but in some of his portraits he is extremely happy. His Cardinal Bentivoglio is a perfect instance of expression in this branch of art. His picture of lord Strafford and his secretary at Wentworth-house, Yorkshire, is another; but the idea is taken from Titian; whose portraits are master-pieces of identical character and expression, and the prototype of Vandyke's excellence. In this respect, sir Joshua Reynolds is no less happy than either of them: prints from whose pictures are in so many hands, and so generally known, that it is needless to exemplify the assertion by further remark, yet we cannot decline mentioning the picture of Mrs. Siddons in the character of the Tragic Muse, as a very happy instance of his power.

Rembrandt, though seldom happy in representing the purity of expression in his figures, yet sometimes effects it; but his great characteristic is the truth with which he gives expression in the secondary sense we have affixed to it, as regarding painting. To imitate the peculiarities of nature was his delight. He seized and expressed, with the greatest truth, the most extraordinary effects of the illumination of objects, and gave it its greatest possible brilliancy and force. In a different line, Netscher and Metzger were highly skilful in the exact expression of the nature of the objects they chose to represent. Silks, furs, carpets, metals, &c. all are expressed by them with the greatest truth, and in a free, broad style of execution, particularly by the former. Teniers, and in short almost all the painters of the Dutch and Flemish schools, have exhibited great ability in expressing the character of natural objects. But to this study they sacrificed attention to expression in its more elevated and useful province.

Not so our inimitable Hogarth. Though he took the common scenes of nature as his field of action; and was not unskilful in imitating the natural effect of objects; yet with him this meaner talent was of secondary consideration. By his pencil he inculcates lessons of morality, and no lectures from the pulpit are more effectually strong and convincing, than those conveyed by his pictures. Witness the Rake's, and the Harlot's Progress; where the evils attendant on vice, and the blessings which a course of virtue is calculated to produce, are so powerfully exemplified. With what force has he satirized pride and luxury in his Marriage-a-la-Mode; bigotry, superstition, and folly, in many of his other works!

and no one has ever expressed identical character more strongly than he has. The figure of the exhausted rake in the breakfast-scene of the *Marriage a-la-Mode*, has never been surpassed in truth and force. We could enlarge with pleasure upon his value in this point of view, but content ourselves with recommending his works with the excellent comments upon them by Mr. J. Ireland, to the perusal and observation of our readers; and are proud to have so excellent an exemplar of the value of expression in painting as Hogarth, whose talents were native, unindebted to foreign schools, in praise of whom to conclude our observations on this very important point.

**EXPROBATION, EXPROBATIO**, in *Rhetoric*, is the reproaching a person with ingratitude, and unmindfulness of some particular benefit conferred upon him.

**EXPUGNATION**, in *Military Language*, the taking of any place by assault.

**EXPULSION**, the act of driving a man by force out of a city, community, or the like.

**EXPULSION** is also used for the act of driving out a foreign body with violence from the place it was in.

The uterus has the chief office in the expulsion of the fœtus: if the expulsion of the fœtus happen very soon after conception, it is called a *false birth*. See **DELIVERY, FŒTUS**, and **LABOUR**.

**EXPURGATION**, in *Astronomy*, is used by some authors for that state or action of the sun, wherein, after having been eclipsed and hid by the interposition of the moon, it begins to appear again.

Later astronomers call this emersion, not expurgation.

**EXQUIMA**, in *Zoology*, the name of a species of monkey common on the coast of Guinea, of which Ray enumerates two or three varieties. See **SIMIA**.

**EXSIBIDANTES**, in *Antiquity*, a kind of dancers, who, in the theatre, and other public auditories, used to make a noise with their feet, and even sometimes beat the seats with battons.

**EXSICCATION**, formed of *ex* and *siccus*, dry, in *Chemistry, Pharmacy, &c.* the act of drying up or evaporating the moisture of a thing. For this purpose two methods are usually employed: in one of which the humidity is evaporated by heat, and in the other it is imbibed or absorbed by substances adapted to the purpose. Bodies combined with, or dissolved in a fluid, require the first mode, and to such as are only superficially blended with it, the second mode is applicable. Vegetables are commonly exsiccated by the natural warmth of the air, though the assistance of artificial heat is often very useful. By a moderate fire the more tender flowers may be soon dried without any considerable loss, either of their odour or lively colour, which would be injured, if not destroyed, by a more slow exsiccation in the air. Some plants, particularly those of the more acrid kind, lose their virtues by this process.

**EXSORS PARTICULA**. See **PARTICULA**.

**EXSUCCATIO**, a word used by some *Chirurgical Writers*, to express an enchymosis, or fuggillation.

**EXSUFFLATION**, a ceremony observed in baptism, by which the candidate was supposed to renounce the d. vil. See **BAPTISM**.

**EXTACY**, *ἔκστασις*, a rapture, or removal of the mind out of its natural state and situation; or a transport, whereby a person is hurried out of himself, and the office of his senses is suspended. See **ENTHUSIASM**.

**EXTACY**, in *Medicine*. See **ECSTASIS**.

**EXTANT**, something that still subsists, or is in being.

It is but part of the history of Livy, of the writings of

Cicero, Cæsar, &c. that are extant, the rest are lost. We have nothing extant of Socrates, though he wrote a great deal.

**EXTEMPORANEOUS PRESCRIPTION**. See **PRESCRIPTION**.

**EXTEMPORANEOUS Playing**, flights in *Music*, on a harpsichord, or piano forte, have many appellations; as toccata, toccatina, *Ital.* prelude, capriccio. On the organ it is called a voluntary.

There have been organists, whose abilities in un-studied effusions on their instruments have almost amounted to inspiration, such as Sebastian Bach, Handel, Marchand, Couperin, Kelway, Stanley, Worgan, and Keeble, several of whom played better music extempore, than they could write with meditation.

**EXTEND**, in the *Manege*. To extend a horse, is an expression used by some to import the same with making a horse go large. See **LARGE**.

**EXTEND**, in *Military Language*. When the files of a line, or the divisions of a column, are to occupy a greater space of ground, they are said to extend their front or line.

**EXTEND**, in *Law*. See **EXTENDING**.

**EXTENDENDA TERRA**. See **TERRA**.

**EXTENDI FACIAS**, in *Law*, a writ of extent, whereby the value of lands is commanded to be made and levied, &c. Reg. Orig. See **EXTENT**.

**EXTENDING**, in a *Legal Sense*, signifies the valuing of lands and tenements of one bound by statute, &c. and who hath forfeited his bond at such an indifferent rate, as that by the yearly rent the obligator may in time be fully paid his debt. See **EXTENT**.

**EXTENSION**, in *Philosophy*, is one of the general and essential properties of matter; the extension of a body being the quantity of space which the body occupies, the extremities of which limit, or circumscribe, the matter of that body. It is otherwise called the *magnitude*, or *size*, or *bulk* of a body.

A quantity of matter may be very small, or so as to elude the perception of our senses, such as a particle of air, a particle of water, &c.; yet some extension it must have, and it is by the comparison of this extension, that one body is said to be larger than, equal to, or smaller than, another body. The measurement of a body consists in the comparison of the extension of that body with some determinate extension, which is assumed as a standard, such as an inch, a foot, a yard, a mile; hence it is said, that a body is a foot long, or three inches long, &c.

The extension of a body is measured three different ways; or a body is said to have length, breadth, and thickness. Thus an ordinary sheet of writing paper is about 16 inches long, about 14 inches broad, and nearly one hundredth part of an inch thick. Either of these dimensions might be called the length, or the breadth, or the thickness; but, by general custom, the greatest extension is called the length, the next is called the breadth, and the shortest is called the thickness. The outside of a body, its boundary, or that which lies contiguous to other bodies that are next to it, is called the *surface* of that body, and this surface has two dimensions only, *viz.* length and breadth; but it has no thickness, for if it had, it would not be the outside of the body; yet a surface by itself cannot exist. In mathematics, however, surfaces are mentioned, and are reasoned upon, abstractly from matter. But in these cases the surfaces exist in the imagination only, and even then our ideas have a reference to body, for our senses cannot perceive a surface without a body.

As a surface is the outside or boundary of a body, so a

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*Line* is the boundary of a finite surface. Suppose, for instance, that a surface is divided into two parts, the common boundary of the two parts is called a line; and this has one extension only, *viz.* it has length.

The beginning, or the end of a line, or the intersection of two lines which cross each other, is called a *point*, and this has no dimensions; or, according to the mathematical definition, a point is that which has no parts or magnitude. Thus, if you divide a line into two parts, the division or boundary between the two parts is a point.

Our senses are only capable of perceiving bodies which have three dimensions; or rather the surfaces of bodies, which surfaces have two dimensions, but a surface cannot be represented nor perceived without a body, and of course neither a line nor a point can be perceived without a body. In the study of geometry, and in a variety of other branches, surfaces, lines, and points are represented upon paper, or upon something else; but in those cases, the paper or that something else is the body whose surface we perceive, and the surface of a particular figure is circumscribed, not by real lines, but by a narrow slip of surface, which is sufficient to direct our reasoning with respect to the geometrical properties of lines and surfaces. Thus also when points are represented by themselves, the marks are not real points, but very small portions of the surface of a body.

There is a case in which extension is often said to be perceived without the existence of a body, and this is the extension between two bodies. But, upon consideration, it will easily be comprehended, that we may perceive the two bodies, and that they are separate from each other; but we cannot perceive any thing positive between them. So that in this case the word extension is used in a figurative manner, as if some other body existed between the two bodies.

The particular extension, whether under the name of inch, foot, yard, metre, league, &c. with which other extensions are compared, or by which they are measured, are established only by the common consent or agreement of persons of a certain nation, or profession, and are used as standard measures by them only. Hence, the measures of different nations, though sometimes they have the same name, do, however, differ considerably from each other. Great endeavours have been made by divers ingenious persons, at different times, for the purpose of determining an unalterable universal standard of measures; but those endeavours, and the successes with which they have been attended, will be found described under the article *STANDARD of Measures*.

Extension is usually described as consisting in the situation of parts beyond parts, with which some authors cavil, maintaining, that we can conceive absolute extension without any relation to parts.

If a man consider the distance between two bodies abstractedly, and without any regard to bodies which may fill that interval, it is called space; and when he considers the distance between the extremes of a solid body, it is called extension.

Extension is frequently confounded with quantity and magnitude; and, for what we can perceive, without much harm, the thing signified by them all appearing to be the same; unless we admit a distinction made by some authors, that the extension of a body is something more absolute, and its quantity and magnitude more respective, or implying a nearer relation to much and little. See *QUANTITY*, *MAGNITUDE*, *MASS*, and *MATTER*.

The infinite divisibility of extension has been a famous question in all ages. It is not easy to reconcile the doc-

trine of mathematicians on this head with the tenets of some philosophers. They who hold that all extension and magnitude are compounded of certain *minima sensibilia*; and that a line, for instance, cannot increase or decrease, but by certain indivisible increments or decrements only, mult, consistently with themselves, affirm, that all lines are commensurable to each other, contrary to the tenth book of Euclid, who demonstrates that the diagonal of a square is incommensurable to its side. But if all lines were composed of certain indivisible elements, it is plain one of those elements must be the common measure of the diagonal and the side. This is a gordian knot which none of the philosophers have yet thought fit to untie.

Bishop Berkeley observes, that the infinite divisibility of finite extension, though it is not expressly laid down either as an axiom or theorem in the elements of geometry, yet is throughout the same every where supposed, and thought to have so inseparable and essential a connection with the principles and demonstrations in geometry, that mathematicians never admit it into doubt, or make the least question of it. (See *DIVISIBILITY*.) And as this notion is the source from whence do spring all those amusing geometrical paradoxes, which have such a direct repugnancy to the plain common sense of mankind, and are admitted with so much reluctance into a mind not yet debauched by learning; so is it the principal occasion of all that nice and extreme subtilty which renders the study of mathematics so difficult and tedious. Hence, says he, if we can make it appear, that no finite extension contains innumerable parts, or is infinitely divisible, it follows, that we shall at once clear the science of geometry from a great number of difficulties and contradictions which have ever been esteemed a reproach to human reason, and without make the attainment thereof a business of much less time and pains than it hitherto hath been.

Every particular finite extension, which may possibly be the object of our thought, is an idea existing only in the mind, and consequently each part thereof must be perceived. If therefore, says this author, I cannot perceive innumerable parts in any infinite extension that I consider, it is certain they are not contained in it; but it is evident, that I cannot distinguish innumerable parts in any particular line, surface or solid, which I either perceive by sense, or figure to myself in my mind; wherefore, I conclude they are not contained in it. Nothing can be plainer to me than that the extensions I have in view are no other than my own ideas; and it is no less plain, that I cannot resolve any one of my ideas into an infinite number of other ideas; that is, that they are not infinitely divisible. If by an infinite extension be meant something distinct from a finite idea, I declare I do not know what that is, and so cannot affirm or deny any thing of it. But if the terms extension, parts, and the like, are taken in any sense conceivable; that is, for ideas; then to say a finite quantity or extension consists of parts infinite in number, is so manifest a contradiction, that every one at first sight acknowledges it to be so. *New Theory of Vision*, § 54, 55. *Analyst*. § 31.

On the other hand, it is observed by an eminent mathematician, that geometers are under no necessity of supposing that a finite quantity or extension consists of parts infinite in number, or that there are any more parts in a given magnitude than they can conceive or express: it is sufficient that it may be conceived to be divided into a number of parts equal to any given or proposed number; and this is all that is supposed in strict geometry concerning the divisibility of magnitude. It is true, that the number of parts into which a given magnitude may be conceived

to be divided, is not to be fixed or limited, because no given number is so great but a greater than it may be conceived and assigned: but there is not therefore any necessity for supposing that number infinite; and if some may have drawn very abstruse consequences from such suppositions, they are not to be imputed to geometry. Geometricians are under no necessity of supposing a given magnitude to be divided into an infinite number of parts, or to be made up of infinitesimals; nevertheless, they cannot so well avoid supposing it to be divided into a greater number of parts than may be distinguished in it by sense in any particular determinate circumstance. But they find no difficulty in conceiving this; and such a supposition does not appear to be repugnant to the common sense of mankind, but on the contrary to be most agreeable to it, and to be illustrated by common observation. It would seem very unaccountable not to allow them to conceive a given line, of an inch in length for example, viewed at the distance of 10 feet, to be divided into more parts than are discerned in it at that distance; since by bringing it nearer, a greater number of parts is actually perceived in it. Nor is it easy to limit the number of parts that may be perceived in it when it is brought near to the eye, and is seen through a little hole in a thin plate? or, when by any other contrivance it is rendered distinct at small distances from the eye. If we conceive a given line that is the object of sight to be divided into more parts than we perceive in it, it would seem that no good reason can be assigned why we may not conceive tangible magnitude to be divided into more parts than are perceived in it by the touch; or a line of any kind to be divided into any given number of parts, whether so many parts be actually distinguished by sense, or not. In applying the reasonings and demonstrations of geometricians on this subject, it ought to be remembered, that a surface is not considered by them as a body of the least sensible magnitude, but as the termination or boundary of a body; a line is not considered as a surface of the least sensible breadth, but as the termination or limit of a surface; nor is a point considered as the least sensible line, or a moment as the least perceptible time; but a point as a termination of a line, and a moment as a termination of a limit of time. In this sense they conceive clearly what a surface, line, point, and a moment of time is; and the postulata of Euclid being allowed and applied in this sense, the proofs by which it is shewn, that a given magnitude may be conceived to be divided into any given number of parts, appear satisfactory; and if we avoid supposing the parts of a given magnitude to be infinitely small, or to be infinite in number, this seems to be all that the most scrupulous can require. See Maclaurin's Treatise of Fluxions-art, 290, 291.

Dr. Reid, in his "Inquiry into the Human Mind, on the Principles of Common Sense," endeavours to obviate the difficulties suggested by Berkeley, by overturning the system of ideas established by Mr. Locke. According to his theory, it is absurd to deduce from sensation the first origin of our notions of external existence, of space, motion, and extension, and all the primary qualities of bodies; they have, he says, no resemblance to any sensation, or to any operation of our minds, and therefore they cannot be ideas either of sensation or reflection; nor can he conceive how extension, or any image of extension, can be in an unextended and indivisible subject like the human mind.

EXTENSION, in the *Ancient Music*, according to Aristoxenus, was one of the four parts of the melopœia, which consisted in sustaining certain sounds longer than their quantity strictly required. We call these binding-notes, and sometimes perhaps tempo rubato. See COMPASS.

EXTENSION of *Fractured Limbs*. See FRACTURE.

EXTENSOR, in *Anatomy*, a name given to those muscles which have the use of extending or making straight those parts to which they are attached.

EXTENSOR *brevis digitorum pedis*; calcaneo-fus-phalangettien commun, is a thin and flat muscle, placed on the superior or convex surface of the foot. Possessing a somewhat quadrilateral figure behind, it divides into four flat tendons in front. It arises from the upper and front part of the os calcis, and from the ligament which connects that bone to the astragalus. Thence its fibres are continued obliquely forwards and inwards, and divide into four secondary fasciculi, (of which the two innermost are the largest,) giving origin to the same number of tendons; which, in passing over the metatarsus, cross those of the extensor longus, and terminate in the toes. The first, on the inside, is attached to the upper surface of the metatarsal extremity of the first phalanx of the great toe; the three succeeding tendons become intimately attached to the external edge of the corresponding tendons of the extensor longus, and are connected at the first joints of the toes, as well as those of the latter muscle, with the tendons of the lumbricales and interossei. They extend over the second phalanges, and are inserted in the third.

Covered on its external surface by the tendons of the extensor longus and peroneus tertius, and by the aponeurosis of the back of the foot, this muscle lies upon the anterior phalanx of the tarsus, upon the metatarsus, and the phalanges.

It extends and elevates all the phalanges of the toes, at the same time turning them rather outwards.

EXTENSORES *carpi radiales*. See CARPI.

EXTENSOR *carpi ulnaris*. See CARPI.

EXTENSOR *communis digitorum manus*; epicondylo-fus-phalangettien commun; extensive digital; a muscle belonging to the fingers, situated on the posterior or dorsal surface of the fore-arm, hand, and fingers; elongated, somewhat rounded and fleshy above, and divided into four tendons below.

It arises above, by means of a tendon common to it with the surrounding muscles, from the external condyle of the humerus; is connected internally to a tendinous partition, which separates it from the extensor of the little finger, externally to a shorter septum placed between it and the extensor carpi radialis brevis, and posteriorly to the fascia of the fore-arm. The fibres, uniting together obliquely from these origins, form a muscle, at first thin, and afterwards more considerable, which is divided, towards the middle of the fore-arm, into four portions, united at first by cellular substance, then separating, and giving origin to the same number of tendons. These at first are connected by a loose cellular substance, pass together with the tendon of the indicator under the annular ligament at the back of the wrist, and in a superficial groove of the radius, surrounded by a bursa mucosa, then diverge towards the fore fingers, and become completely flattened. They are often split longitudinally, and are united to each other, at the back of the hand, by cross slips of tendon and their aponeuroses. At the first joints of the fingers the broad thin tendons of the extensor communis are joined, on either side by the tendinous expansions of the lumbricales and interossei, and completely cover the articulation. They divide, at their extremities, into three portions, the middle of which are inserted in the second phalanges of the fore-fingers; while the lateral divisions, running along the sides of these phalanges, are inserted close together into the third.

This muscle is covered by the aponeurosis of the fore-arm,

## EXTENSOR.

the annular ligament and skin. It covers the supinator radii brevis, the extensors of the thumb and fore-finger, the carpus, metacarpus, interossei muscles, and posterior surface of the phalanges.

The annular ligament at the back of the fore-arm consists of a broad, thin, and flat, but strong fibrous expansion, extended from the outer part of the carpal extremity of the radius, over all the extensor tendons at the back of the wrist, and connected to the end of the ulna; and to the os pisiforme. It confines the tendons to the surface of the bones. Those of the common extensor are surrounded, as they pass under it, by a synovial membrane, in which we may distinguish a cavity containing the membranes completely isolated, and a superior and inferior cul de sac, where the membrane is reflected over the tendons. The synovial membranes of the first joints of the fingers are closely connected to the tendons of the extensor communis, where they pass over those joints.

This muscle extends the different joints of the fingers; and afterwards, or if the fingers are bent by their flexors, it extends the wrist upon the fore-arm.

*EXTENSOR indicis.* See INDICATOR.

*EXTENSOR longus digitorum pedis*; peroneo-tibi-fus-phalangettien commun; grand extenseur; is a long, thin muscle, flattened laterally, and placed at the outer and anterior part of the leg, and upper part of the foot. It arises above from the external tuberosity of the tibia, from a small aponeurotic septum which separates it from the tibialis anticus, and from the anterior ligaments of the peroneo-tibial articulation; behind from five or six inches of the upper and anterior part of the fibula; before, at its upper part, from the aponeurosis of the leg; and externally, from a broad aponeurotic septum, which separates it from the two peronei. The superior fibres descend perpendicularly, the inferior ones more and more obliquely, to end in a common tendon at first concealed in the substance, but, from the middle of the leg, occupying the anterior edge of the muscle. It divides into three or four portions, which pass together behind the annular ligament: below which part we always see four separate tendons diverging over the convexity of the foot, assuming a broad and flattened form, and crossing the direction of the tendons of the extensor brevis, in their passage to the four smaller toes. At the first joints of the toes these tendons are connected to those of the extensor brevis, and of the lumbricales and interossei, as in the hand, and they have similar insertions to those of the extensor communis digitorum, which see.

In the leg, this muscle, on its inner surface, is separated above by the anterior tibial vessels from the tibialis anticus; lower down it is contiguous, on the same aspect, with the extensor proprius hallucis; externally it is in contact with the peronei; and the aponeurosis of the leg covers it on the front. At the ankle it runs in a peculiar cavity of the strong transverse annular ligament, which binds it firmly down in its place. Here the tendons are surrounded by a synovial membrane. In the foot it is covered by the skin, and covers the extensor brevis and phalanges.

This muscle extends the toes, and afterwards bends the ankle joint. If the foot be fixed to the ground, it may either maintain the leg erect upon the foot, or carry it forwards.

*EXTENSOR longus pollicis pedis*; or *proprius*; peroneo-fus-phalangien du pouce; thin, elongated and flattened in its form, it lies on the inside of the preceding muscle. It arises from the inner and anterior part of the fibula, and neighbouring portion of the interosseous ligament, for a space of five or six inches, beginning about two inches

below the upper end of the fibula. Its fibres pass obliquely downwards and forwards, parallel to each other, and joining a tendon which runs along their anterior edge, constitute a single penniform muscle. The tendon goes behind the annular ligament, in a peculiar bursa mucosa, runs along the inner edge of the metatarsus, and passing over the first, terminates in the second phalanx of the great toe. Sometimes a small portion of its tendon is inserted in the first phalanx.

This muscle is placed between the tibialis anticus, the anterior tibial vessels and nerves being however interposed, and the extensor longus digitorum. On the front it is covered by the aponeurosis of the leg, the annular ligament, and the integuments. Its tendons lie on the lower end of the tibia, the tarsus, metatarsus, and phalanges of the great toe, and is closely connected to the synovial membrane of the first joint of that toe.

It extends the two joints of the great toe, and acts upon the foot in the same manner as the preceding muscle.

*EXTENSOR major pollicis.* See *EXTENSORES pollicis*.

*EXTENSOR minor pollicis.* See *EXTENSORES pollicis*.

*EXTENSOR ossis metacarpi pollicis.* See *EXTENSORES pollicis*.

*EXTENSORES pollicis*; are three muscles belonging to the three bones of the thumb.

*EXTENSOR primi internodii*; extensor ossis metacarpi pollicis; abductor pollicis longus of Albinus; cubito-radialis metacarpien du pouce; grand abducteur du pouce; is a muscle of an elongated, thin, and flattened form, situated obliquely on the back of the fore-arm. It arises above from the ulna, below the supinator radii brevis; from the interosseous ligament; and from the radius just below the insertion of the supinator brevis. The fleshy fibres unite together from these origins to form a flattened fasciculus at first small, but afterwards larger, which crosses the fore-arm obliquely from above downwards, and from the radial towards the ulnar side. Towards the lower extremity of the radius it terminates in a tendon, which runs in a small groove on the outer side of the carpal extremity of the bone. Here it is surrounded by a hollow bursa, common to it with the tendon of the next muscle. It is inserted, generally by means of several more or less distinct portions, into the radial side of the carpal end of the first phalanx of the thumb. One of these portions is often connected with the abductor pollicis.

It is covered, in its fleshy portion, by the extensor carpi ulnaris, extensor secundi internodii, extensor proprius auricularis, and communis digitorum; and it covers the radius, ulna and interosseous ligament. Its tendon is covered by the aponeurosis of the fore-arm, and covers the extensores carpi, the radius, radial artery, and joint of the wrist.

It extends the first bone of the thumb, when that has been bent towards the palm of the hand. It carries the thumb away from the other fingers; and it may move the whole hand towards the radius.

*EXTENSOR secundi internodii*; extensor minor pollicis; cubito-fus-phalangien du pouce; is an elongated and slender muscle, situated close to the former, and lying on its ulnar edge. Arising from the interosseous ligament and radius, it crosses the direction of the fore-arm, like the former, and forms a slender tendon, which closely accompanies that of the preceding muscle. It passes along the first, and is inserted in the second phalanx of the thumb. It is covered by the extensor tertii internodii, proprius auricularis, and digitorum communis, by the aponeurosis of the fore-arm, and the integuments. It lies upon the bones of the fore-arm and the interosseous ligaments, the extensores carpi radiales, the

joint

joint of the wrist, and the first bone of the thumb. It extends the first and second joints of the thumb, and carries it into the state of abduction. It may draw the whole hand towards the radius.

*EXTENSOR tertii internodii*; *extensor major pollicis*; *cutibito-sus-phalangettien du pouce*; is an elongated and slender muscle, placed close on the ulnar edge of the former, and following the same general direction. It arises from the middle third of the posterior surface of the ulna, and a very little from the interosseous ligament; and crosses the fore-arm obliquely towards the thumb. Surrounded by a hollow bursa, it runs along a peculiar groove of the radius, being placed about an inch on the ulnar side of the preceding tendons. It passes along the ulnar side of the first phalanx of the thumb; is connected with the insertion of the preceding tendon in the second phalanx, and terminates in the third. Situated at its origin between the bones of the fore-arm and interosseous ligament, and the *extensor communis*, *proprius auricularis*, and *carpi ulnaris*, it afterwards runs in its peculiar groove: it is then sub-cutaneous, and lies on the *extensores carpi*, joint of the wrist, and bones of the thumb. It extends all the joints of the thumb, and at the same time rather carries it towards the fingers. It will also act as an extensor of the wrist.

*EXTENSOR proprius auricularis*, or *digiti minimi*; *epicondylo-sus-phalangettien du petit doigt*; is a thin, slender, and elongated muscle, situated in the first or superficial layer of the back of the fore-arm, and placed close along the ulnar side of the *extensor digitorum communis*. It arises above by means of the common tendon, from the external condyle of the humerus; on the outside, from a septum, which separates it from the *extensor communis*; on the inside, from one interposed between it and the *flexor carpi ulnaris*; and behind, from the aponeurosis of the fore-arm. It gives origin to a slender tendon, which passes in a separate canal of the annular ligament, and forming the tendon which the little finger receives from the *extensor communis*, is inserted together with it into that finger. On the fore-arm, this muscle is covered by the fascia, and covers the *supinator brevis*, the *extensores* of the thumb, and the *indicator*. The *extensor communis* lies on its outside, and the *extensor carpi ulnaris* on the inside. Its tendon is surrounded by a tendinous sheath, lined with a synovial membrane, at the wrist; and afterwards is covered by the integuments lying on the last metacarpal bone, and on the phalanges of the little finger. It extends the little finger, and afterwards moves the wrist in the same direction; it will carry the little finger rather in the direction of abduction.

*EXTENSOR proprius pollicis pedis*. See *EXTENSOR longus pollicis pedis*.

*EXTENSOR tarsi minor*, a name given by Douglas to the plantaris, which see.

*EXTENSOR tarsi suralis*, or *magnus*; a name under which Douglas classes the *gastrocnemius* and *soleus*. See those words.

**EXTENT**, or **EXTENDI FACIAS**, in *Law*, sometimes denotes a writ or commission to the sheriff for the valuing of lands and tenements; sometimes the act of the sheriff or other commissioner upon this writ; and sometimes the estimate or valuation of lands, *per proprios viros*; which, when taken at the utmost value or extent, furnish our extended, or rack-rents. *Fleta*. lib. ii.

This is a species of *execution* (which see) upon some securities given by statute; as in the case of recognizances or debts acknowledged on statutes-merchant, or statutes-staple; upon forfeiture of which, the body, lands, and

goods may be all taken at once, to compel the payment of the debt. And by statute 33 Hen. VIII. c. 39. all obligations made to the king shall have the same force, and of consequence the same remedy to recover them, as a statute-staple; though, indeed, before this statute, the king was entitled to sue out execution against the body, lands, and goods of his accountant or debtor. (3 Rep. 12.) And his debt shall, in suing out execution, be preferred to that of every other creditor, who hath not obtained judgment before the king commenced his suit. The king's judgment also affects all lands, which the king's debtor hath at or after the time of contracting his debt, or which any of his officers, mentioned in the statute 13 Eliz. c. 4. hath at or after the time of his entering on the office; so that, if such officer of the crown alienes for a valuable consideration, the land shall be liable to the king's debt, even in the hands of a *bonâ fide* purchaser; though the debt due to the king was contracted by the vendor many years after the alienation. (10 Rep. 55, 56.) Whereas judgments between subject and subject reverted, even at common law, no farther back than the first day of the term in which they were recovered, in respect of the lands of the debtor; and did not bind his goods and chattels, but from the date of the writ of the execution: and now, by the statute of frauds, 29 Car. II. c. 3; the judgment shall not bind the land in the hands of a *bonâ fide* purchaser, but only from the day of actually signing the same; which is directed by the statute to be punctually entered on the record; nor shall the writ of execution bind the goods in the hand of a stranger, or a purchaser (Skin. 257.); but only from the actual delivery of the writ to the sheriff or other officer, who is therefore ordered to endorse on the back of it the day of his receiving the same. *Blackst.* Comm. book iii.

**EXTENUATION**, the act of diminishing or lessening the bulk or substance of a thing, especially of the human body. Fevers, agues, long abstinences; &c. occasion great extenuations or emaciations.

**EXTENUATION** is also a figure in *Rhetoric*, opposite to the hyperbole. The Greeks call it *λετομία*.

**EXTERIOR Polygon, Talus**. See the substantives.

**EXTERMINATION**, formed of *ex* and *terminus*, boundary, the act of extirpating, or totally destroying a people, race, family, &c.

The Jews have been exterminated out of Portugal, the Moors out of Spain, the Albigenes out of France, &c. Philip the Fair of France, to be revenged on the Knights Templars, took a resolution, in 1307, to exterminate them.

**EXTERMINATION**, or *Exterminating*, in *Algebra*, is used for taking away. Thus algebraists speak of exterminating surds, fractions, and unknown quantities out of equations. See *Maclaur.* *Algebr.* part i. chap. 12, where we have some general theorems for the exterminating unknown quantities in given equations. See **EQUATION**.

**EXTERNAL**, or **EXTERIOR**, a term of relation, applied to the surface or outside of a body; or that part which appears or presents itself to the eye, touch, &c. In which sense it is opposed to *internal* or *interior*.

The senses are divided into external, which are those whereby we perceive ideas, or have the perception of external objects; as seeing, hearing, &c. and internal. See **SENSE**.

**EXTERNAL** is also used to express any thing that is with-outside a man, or that is not within him, and particularly in his mind. In which sense we say external objects, &c.

The existence of an external world, *i. e.* of bodies and objects out of the mind, is a thing which has been greatly called

called in question by Dr. Berkeley and others. See **EXISTENCE**, **BODY**, and **QUALITY**.

**EXTERNAL Angles.** See **ANGLES**, *external*.

**EXTERNAL Denomination, Ear, Modes, Place.** See the substantives.

**EXTERNUS AURIS**, in *Anatomy*. See **EAR**.

**EXTERNUS Cubitus.** See **CUBITÆUS**.

**EXTERNUS Duverni**, a name given by Douglas to one of the muscles of the ear, called by Cowper and others *obliquus auris*, and by Albinus *externus mallei*. See **EAR**.

**EXTERNUS Gastrocnemius, Iliacus.** See the substantives.

**EXTERNUS Mallei.** See **EAR**.

**EXTERNUS Orbiter, Pterigoideus, Vastus, Rectus Capitis,** See the several articles.

**EXTINCTION**, the act of extinguishing, that is, of putting out, or destroying, fire, flame, or light.

The Aristotelians account for the extinction of fire from the principle of contrariety; thus, say they, water puts out fire, because the qualities of water are contrary to those of fire, the one being cold and moist, and the other hot and dry. But how far this will go, may appear hence, that fire is extinguished by hot water as readily as cold; nay, even by oil, earth, &c.

Some of the moderns offer two more plausible causes of extinction; *viz.* dissipation, as when the next immediate fuel of the flame is dispersed and blown off by too forcible a wind; and suffocation, when it is so compressed, that its free motion cannot be maintained; as happens upon throwing water, &c. thereon. Various preparations and engines have been contrived for extinguishing accidental fires. See **FIRE**.

Boerhaave denies that there is properly any such thing as extinguishing of fire; it is a body *sui generis*, of an immutable nature, and we can no more extinguish or destroy it than we can create it.

**EXTINCTION**, in *Chemistry* and *Pharmacy*, is when a metal, mineral, or the like body, after having been heated red-hot in the fire, is plunged in some fluid, either to soften or temper its acrimony, as tutty in rose-water; or to communicate its virtue to the liquor, as iron or steel to common water; or, lastly, to give it a temper, as in the extinction of steel in water, or some other preparation.

**EXTINGUISHER, SELF-ACTING**, is a contrivance whereby a candle can be extinguished at any given time after being lighted. There are several ways by which this can be effected. The most simple is placing the candle in a vessel of water, with such a length above the surface as will burn as long as a light is wanted; of course when the candle burns down to the water it will be extinguished.

*Figs. 10 and 11, Plate XII. Miscellany*, represent two neat mechanical contrivances for the above purpose; in *fig. 10*, *a a* is a brass clip, formed of two pieces, and jointed together by the pin, *b*, by means of a sliding ring, *d*; this clip can be closed round the candle so as to fix firmly thereto; the pin, *b*, has a joint in the upper end to receive a crooked lever, *e*, which has a conical extinguisher fastened at the other end of it. This extinguisher is held up from falling upon the candle, by means of a small wire, *f*, which is bent sideways at the end, and thrust into the candle, at the place where it is intended to be put out; as the tallow is consumed, it becomes so soft as to be unable to sustain the pressure of the wire, *f*, which therefore flies forward, and the extinguisher falls upon the candle. It must be observed that the wire, *f*, must only be put into the tallow, but not in the wick, as it might not then fall down quickly.

*Fig. 11* is another extinguisher, invented by Mr. J. J. Hawkins, and placed in his museum of mechanical inven-

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tions: *a a* is a pair of nippers, made of tinned iron plate, and jointed in the middle; between the outer ends a piece of watch-spring is fixed, which causes the ends, *b*, to close upon the candle, and thus hold the extinguisher on the candle. The centre-pin of the joint is long enough to serve for the centre of another clip, *b b*, which is exactly similar to the lower one, except that instead of the bow to embrace the candle, two wires, *c, c*, are fixed to the ends, to shut the extinguisher, which is composed of two flat plates, *f, f*, which open and shut upon the joint, *g*. The spring between the ends of the nippers, *b, b*, has a constant tendency to close the extinguisher, but is prevented from shutting by the candle. When the candle burns away, it becomes lost at the place where the extinguisher bites the spring; then shuts it up, and puts out the light.

**EXTINGUISHMENT**, in *Law*, is used for a consolidation. Thus, if a man, having a yearly rent due to him out of my lands, afterwards purchase the same lands; both the property and rent, becoming consolidated, or united in one possessor, the rent is said to be extinguished.

So, where a man has a lease for years, and afterwards buys the property, there is a consolidation of the property, and an extinguishment of the lease.

But if a man have an estate in land merely for life or years, and hath a higher estate in a fee-simple, in the rent, this rent is not extinguished, but in suspense for a time; for, after the term, the rent shall revive. (*Terms de Ley.*) See **RELEASE**.

So also, if there be lord mesne and tenant, and the lord purchase the tenancy, the mesnalty is extinct.

Likewise by purchasing of lands wherein a person hath common appendant, the common is extinguished. (*Cro. El. 594.*) A release of common in one acre, is an extinguishment of the whole common. *Showers's Rep. 350.*

And where a person hath common of vicinage, if he incloses any part of the land, all the common is extinct. (*1 Brownl. 174.*) If a man hath a highway appendant to land, and afterwards purchaseth the land wherein the highway is, the way is extinct: though it is held, that a way of necessity to a market or church, or to arable land, is not so extinguished. *11 Hen. VII. 25 Co. Litt. 155.*

**EXTINGUISHMENT of a copyhold** takes place on any act of the copyholder's, which denotes his intention to hold no longer of his lord, and amounts to a determination of his will. (*Hutt. 81. Cro. Eliz. 21. 1 Jon. 41.*) As if a copyholder in fee accepts a lease for years of the same land from the lord, or accepts an assignment of a lease made to another from the lessee, his copyhold is extinct. (*Moor. 184. 2 Co. 166. Godb. 11. 101.*) A copyhold estate is extinct whenever it becomes not demisable by copy. *Coke's Copyholder, 62.* See **COPY-HOLD**.

**EXTINGUISHMENT of debt** happens in a variety of cases. Thus, if a creditor accepts a higher security than he had before, or accepts a bond for a legacy, the first debt or legacy is hereby extinguished.

**EXTINGUISHMENT of liberties.** If liberties and franchises granted by the king, such as felon's goods, waifs, strays, wrecks, &c. (*9 Rep. 25.*) come again to the crown, they are extinct in the crown, and the king is seized of them *jure corona*: but if liberties of fairs, markets, or other franchises, and jurisdictions, be erected, and created by the king, they will not be extinguished, nor their appendances severed from the possession. *9 Rep. 25.*

**EXTINGUISHMENT of services.** If the lord purchases or accepts any part of the tenancy, out of which an entire service is to be paid or done, the service becomes thereby extinct; unless it be for the public good, or homage and

fealty, which are not subject to extinguishment. (6 Rep. 1. 105. Co. Litt. 149.) If the lord and another person do purchase the lands out of which he is to have services, they are extinct; also by severance of the services a manor may be extinguished. Co. Litt. 147. 1 And. 257. See T E N U R E.

EXTINGUISHMENT of ways. See EXTINGUISHMENT.

EXTIRPATION, formed of *ex* and *stirps*, root, the act of pulling up, or destroying, a thing to the very roots.

Among the prayers of the Romish Jubilee, there is one for the extirpation of heresy.

EXTIRPATION. This word, in *Surgery*, signifies the eradication of any disease, tumour, &c. by some manual operation, whether done with a cutting instrument, with caustic, with a ligature, or any other means.

Thus, the generality of tumours are extirpated with a knife; but some, which class as excrescences, or warts, are frequently extirpated with caustic, or with the ligature. The extirpation of polypi in the nose is, for the most part, accomplished with forceps, by which such tumours are pulled, or rather twisted off.

The art of extirpating encysted tumours with adroitness consists in dissecting the parts, surrounding the tumour, without wounding the cyst. If the latter accident occur, the contents frequently flow out, the cyst collapses, and the continuance of the dissection is attended with more difficulty. It is a great point to remove every particle of the cyst, and, hence, it is satisfactory to take it out entire, that is, without wounding it. When any portion remains behind, the wound will frequently not heal, in consequence of fungous granulations, arising from the diseased part. Unless the swelling be large, a single incision through the skin is sufficient; but, in other instances, it is advantageous to make

two cuts in this manner ( ) ; first, because it facilitates the removal of the tumour; secondly, because it prevents a redundancy of skin, which would take place, if none were removed, and would greatly retard the cicatrization of the wound.

After the operation, the edges of the wound are to be brought together with sticking plaster, and a compress and bandage are to be applied.

When the breast is affected with any disease of an incurable nature, the surgeon can sometimes extirpate the malady by cutting away the whole of the diseased parts.

If the disease be of a scirrhous or malignant nature, some particularity in the mode of operating is requisite. The surgeon ought, in this case, not to be content with merely removing parts, which are palpably and visibly diseased; but he should also endeavour to remove a certain quantity of the substance, which is in the immediate circumference of the disease. In scirrhus, every surgeon knows the propensity of the skin to be affected, and the frequent extension of white morbid bands into the surrounding adipose substance. These facts greatly confirm the propriety of making a free removal of the skin, whenever it is in the least discoloured, puckered, adherent to the swelling beneath, or in any way altered; and of taking away a good deal of the fat, in which scirrhous tumours are sometimes involved. When there are no reasons for supposing the disease of the breast to be any thing else than a mere sarcomatous enlargement, the removal of the skin must certainly be considered unnecessary. When cancer recurs, the skin is the first part in which it usually makes its appearance, and the skin of the nipple in particular. Hence, many surgeons always make it a rule to remove the latter part, when it is judged proper to take away any of the integuments.

The operation is usually performed as the patient is in a sitting posture, well supported by pillows and assistants.

The pectoral muscle is to be made tense by keeping the arm back, by means of a stick, placed transversely behind the back, in front of the two arms.

If none of the integuments are to be removed, a straight incision is to be made through them; the tumour is to be regularly dissected all round from the circumjacent parts; and, lastly, its base is to be detached from its connections, from above downward, till the whole is separated.

This is the mode of removing all simple tumours, which are not of a malignant nature, and which are not of an immense size.

When the tumour is of a malignant nature, and adherent to the skin and pectoral muscle beneath, the operator is to remove, at least, an inch or two of the fat on every side of the disease. The portion of the skin intended to be taken away must be included in two semi-circular incisions, which meet thus ( ) at their extremities; and when the base of

the tumour is to be detached, the surface of the pectoral muscle, wherever it is adherent to the tumour, is also to be removed.

It is sufficiently obvious, that the advantage of making the incision in the above manner consists in enabling the surgeon to bring the edges of the wound together after the operation, so as to form a straight line, and unite by the first intention.

The mere magnitude of a tumour frequently renders it highly judicious to take away a portion of the skin in the above method. If some were not removed, the dissection of the tumour would be exceedingly tedious; and, after the operation, the loose undistended skin would lie in folds, and form, as it were, a large pouch for the lodgment of matter.

The tumour being removed, the surgeon should examine the interior of the wound, in order to ascertain that no indurated part is left behind. If any hardness should be felt, it is proper to remove it. The surgeon should also examine the surface of every scirrhous tumour, immediately after it is taken out, for the purpose of knowing whether any of the white bands, shooting into the surrounding fat, have been divided; for, in this case, some portions have been left behind, and ought to be taken away. Their situation may easily be known, by considering the position of the tumour before the operation.

When the dissection of a swelling will occupy a considerable time, it is always judicious practice to tie every large artery as soon as it is divided. This remark is not meant to comprehend vessels of such a diameter, that though they bleed when first cut, they do not emit blood afterwards, so as to require a ligature. It was Desault's invariable method, in cutting out tumours, to tie every large artery before he continued the dissection.

When a tumour of the breast has been entirely detached, and the hemorrhage suppressed, the stick confining the arm backward is to be removed. Then if there are any diseased glands in the axilla, it is a very excellent plan to tie the pedicles, by which they are attached on the side towards the axilla, before attempting to cut the tumours completely away. It would be extremely difficult, after taking off the gland, to tie the little short artery which enters the swelling, almost immediately after it has quitted one of the thoracic arteries. The bleeding also, in consequence of the shortness of the vessel, and vicinity of its orifice to the thoracic arteries, would be exceedingly profuse, seeming rather

rather to arise from a wound of the latter vessels than of a small branch.

The celebrated Default used to pursue the practice above recommended; and sir Charles Blicke has long been in the habit of observing the same rule, in the numerous operations which he has performed with the utmost benefit to the afflicted, and well deserved honour to himself.

When the operation is finished, the skin of the wound is to be relaxed, and the edges of the incision brought together with strips of adhesive plaster. Proper compresses and bandages are next to be applied. Should the operation have been the removal of a diseased breast, the nearest arm should be kept completely at rest in a sling, as whenever it moves, it occasions a disturbance of the pectoral muscle, and, of course, of the wound. (First lines of the "Practice of Surgery," by Samuel Cooper.)

For the mode of extirpating a diseased testis, see CASTRATION.

The method of effecting the extirpation of polypi is to be described in the article POLYPUS.

Some observations are offered, under the head EXOSTOSIS, on the subject of extirpating tumours of the bones. The way in which a diseased eye ought to be cut out, will be hereafter explained. See EYE, *Extirpation of*.

For an account of the plan of extirpating certain excrescences, see EXCRESCENCE.

EXTIRPATIONE, in *Law*, a judicial writ, either before or after judgment, that lies against a person, who when a verdict is found against him for land, &c. doth maliciously overthrow any house, or extirpate any trees upon it. Reg. Jud. 13. 56.

EXTISPES, formed of *exta*, and *spicere*, of *spicio*, or *inspicere*, *I view, consider*, in *Antiquity*, an officer who viewed and examined the intrails of victims; in order to draw presages from them as to futurity.

This kind of divination, called extispicium, was much in vogue throughout Greece, where there were two families, the Jamidæ and Clytidæ, consecrated, or set apart, peculiarly for it.

It appears to have been very ancient, and was probably derived from the ancients. Vitruvius, cap. 4. lib. i. gives the following plausible account of its origin. He says that the ancients inspected the livers of those animals which frequented the places where they intended to build or encamp; and if they commonly found that the liver, to which they attributed sanguification, was injured, they concluded that the waters and nourishment collected near such places were not wholesome.

In Italy, the first extispices were the Etrurians or Tuscan; among whom, likewise, the art was in great repute. Lucan gives us a fine description of one of these operations in his first book.

EXTORTION, in *Law*, denotes generally any oppression under colour of right; and it is usually applied to signify an illegal manner of wresting any thing from a man, either by force, menace, or authority: *e. g.* if an officer, by terrifying another on pretence of his office, or "by colour of his office," takes more than his ordinary fees or dues, he commits, and is indictable for, extortion.

So the exacting of unlawful usury, winning by unlawful game, and, in fine, all taking of more than is justly due, by colour or pretence of right, as excessive tolls in millers, excessive prices of ale, bread, victuals, wares, &c. come under extortion.

Crompton says, that wrong done by any man is properly a trespass, but excessive wrong is extortion; which is most properly applicable to sheriffs, mayors, bailiffs, and

other officers, who, by colour of their office, greatly oppress and wrong the king's subjects, by taking excessive reward, or fees, for executing their office: and extortion has been deemed more odious than robbery, because it carries an appearance of truth; and is often accompanied with perjury in officers, &c. by violating their oaths of office. The distinction between bribery and extortion seems to be this: the former offence consists in the offering a present, or receiving one if offered; the latter, in demanding a fee, or present, by colour of office. Extortion by the common law is severely punished, on indictment, by fine and imprisonment, and removal of officers from the offices in which the crime was committed. By the stat. 3 Edw. I. inferior officers of justice, &c. guilty of extortion, are to render by c. 26. double, and by c. 30. treble, value; and there are divers other statutes for punishing extortions of sheriffs, bailiffs, gaolers, clerks of the assize, and of the peace, attorneys and solicitors, &c. stats. 23 H. VI. c. 7 & 9. 33 H. VIII. c. 24. 29 Eliz. c. 4. 1 Jac. I. c. 10. 9 & 10 W. III. c. 41. 10 & 11 W. III. c. 23. 3 Geo. I. c. 15. 17 Geo. III. c. 26. § 6. In cases of extortion, there must be a positive charge, that the charged person did it *extorsivè*, or *colore officii*. The place where it was committed must be set down in the declaration; the sum extorted particularly specified, and the indictment or information must state the full particulars by specifying the time, &c. Against attorneys for extortion, action may be brought, and the party aggrieved shall have treble damages and costs; but information will not lie on the stat. 3 Jac. I. c. 7. Sid. 434. 4 Nels. 822.

EXTRA-Constellary Stars. See SPORADES.

EXTRA-judicial, something done out of the proper court, or the ordinary course of law. As when judgment is given in a cause, or case, not depending in that court where such judgment is given, or wherein the judge has no jurisdiction.

EXTRA-mundane space, is the infinite empty void space, which is by some supposed to be extended beyond the bounds of the universe, and consequently in which there is really nothing at all.

EXTRA-parochial, a place out of the bounds of any parish; or privileged and freed from the duties of a parish.

EXTRACT, in *Chemistry*. The term extract, as used in chemical nomenclature, has been borrowed from the pharmaceutical dispensaries, where it has long been applied to a great variety of substances which have little other agreement than in the mode of preparation, which consists in extracting by water, or any other menstruum, the soluble part of certain parts of vegetables, and inspissating this solution by heat to a thick consistence, or sometimes to entire solidity.

The term extract, therefore, in its original and pharmaceutical sense, only refers to the mode of preparation, and not to the nature of the substance prepared; and hence much confusion and uncertainty have prevailed in the attempts of chemists to define the nature of the substance to which this term should in strictness be limited.

All the pharmaceutical extracts are extremely compounded, for being prepared either by water or alcohol, of course every thing soluble in these liquids would be confounded in the general mass. Hence we find in one or other, and sometimes in a single extract, mucilage, sugar, tannin, gallic acid, resin, gluten, several neutral salts, and other ingredients. But along with these there always is found a considerable quantity of a brown tenacious substance, often with a bitter taste, and possessing a number of chemical properties, which entitle it to be considered as a peculiar sub-

## EXTRACT.

stance, and to which the term extract, or extractive principle, has been given.

The distinguishing properties of this substance have been laid down with much ability by Vauquelin, in his memoir on the extractive principle (*Journal de Pharmacie*, p. 132.) and in his researches on the sap and native juices of trees (*An. Chem.* tom. 31.) and also by Fourcroy in an elaborate and excellent analysis of the cinchona of St. Domingo. *An. Chem.* tom. 8 & 9.

We shall first notice the experiments of Vauquelin, which being made on the native juices of plants, the extract already in solution, and unaltered by the heat requisite in artificial decoction, is probably in a purer state.

When the sap of any tree is first drawn it is always colourless, or nearly so, but when inspissated by heat, however moderate, it always assumes a brown colour, and in the process of evaporation a certain though small quantity of pulverulent brown insoluble matter falls down. If this is collected separately before the juice is entirely inspissated, and treated with muriatic acid, one portion dissolves with effervescence, and is found to be chiefly carbonate of lime, and an insoluble part remains, which is considered by this excellent chemist as extract altered and oxygenated during the evaporation. If the concentrated sap is now slowly evaporated to dryness, it yields a brown extract, strongly deliquescent, and of a pungent saline taste. This entire extract is always extremely compounded, containing in fact all the soluble ingredients of the original juice. Gallic acid, when present, is detected by a solution of iron; tannin, by a solution of isinglass; salts of lime, by oxalic acid; sugar, by the taste, and by its soon acquiring the vinous fermentation. The entire extract also always contains acetic acid, partly in excess and partly united both to lime, potash, and ammonia, and hence when a few drops of strong sulphuric acid are poured upon any extract, copious vapours of pungent acetic acid are given out; and if this is done with large quantities, and in close vessels, acetic acid may be obtained pure. It is probably owing to the presence of these neutral acetites, that all the inspissated native juices attract moisture strongly from the air, and hence too their great disposition, to mould and change by keeping.

Ammonia also is detected in most inspissated juices of plants by the pungent vapours of this alkali, that are perceived on the addition of quick-lime, but in the natural state the ammonia is more than neutralized by the acetic acid, as all the soft extracts redden betimes.

Extractive matter (meaning by this term the pure extract) appears to form a great portion of the colouring matter of vegetables. If to any liquid containing extract a solution of alum be added, a copious coloured insoluble precipitate is produced, consisting chiefly of alumine in intimate combination with extractive matter, and the supernatant liquor remains clear and nearly colourless. The same process takes place in dyeing, the alum being first fixed on the cloth as a mordant, as it is called. The solutions of tin possess this power of precipitating coloured extract as an insoluble powder in a still more striking manner. That of the other metallic salts produce a similar precipitate of extract, combined with the metallic oxyd.

The experiments of Fourcroy on the cinchona have been detailed at length under that article, to which we refer our readers. It may be observed in this place, that the facts relative to the subject of extract were, shortly, that the decoction of cinchona during evaporation deposited a quantity of black matter, insoluble in cold water, but which mostly was dissolved in alcohol, leaving however a portion of a red powder of a peculiar nature, which the author of

the experiments considers as extractive matter, changed by union with oxygen, and thereby rendered insoluble in water or alcohol. The appearance of this powder, and its insolubility in water, might at first lead to the supposition that it was resin, but its equal insolubility in alcohol refutes this idea.

The precise nature of this insoluble matter, which is deposited on the evaporation of all vegetable infusions or decoctions, is hitherto not known, and several objections to the opinion of its being merely oxygenated extract may be adduced, which we have already detailed under the article CINCHONA.

On the whole, however, we may safely admit, that there is a peculiar substance found in almost all soluble matter of vegetables, and particularly in the common circulating juices, to which the term extract, or pure extractive principle, has been given, and which has the following distinguishing properties.

In its natural state in the sap of trees it is colourless, or nearly so; but when the solution is heated and inspissated, it always acquires a deep colour, which is generally brown or fawn, with various shades, and by the same process its solubility in cold water is diminished.

It is in its natural state equally soluble in alcohol as in water, by which circumstance it is distinguished both from pure mucilage and resin.

It is insoluble in ether.

It has a very strong affinity with alumine, and with metallic oxyds, and when combined with ether it becomes insoluble in water, alcohol, and many other menstrua. By destructive distillation it is resolvable into carbon, oxygen, and hydrogen, and a small proportion of azot.

Much variety is found in the properties of smell, taste, and colour, in the various extracts, and we are still totally ignorant how far these varieties may depend on other admixtures, or whether there are different species of extract; and in general we may add that this substance appears to be one which most easily enters into intimate combination with all the other soluble vegetable principles, and, consequently, can hardly by any known means be obtained pure, as it exists in the vegetable itself, and unchanged by the processes of analysis.

**EXTRACT, in Pharmacy.** The greater number of pharmaceutical extracts are made by boiling the substance (in coarse powder) in water, straining the decoction, boiling it down till it is considerably concentrated, then gently drying the residue in a stove, or slow oven, to the requisite consistence.

A few of the extracts are made with alcohol instead of water, or with a mixture of the two; the substance being first digested with the alcohol, and the tincture, thus prepared, strained off; the residue then boiled with water, and the decoction poured off, and both the decoction and tincture mixed, and evaporated slowly.

The purely spirituous extracts are also called resins, and are always evaporated to dryness, when they remain hard brittle masses, with a vitreous fracture, resolvable in alcohol, and in all essential characters resembling the natural resins.

In preparing the extracts by water the decoctions are usually directed to be set aside for some hours, that any sediment may be deposited, which last is to be rejected. But this is obviously a bad practice, as in many cases much of the medicinal property of the plant resides in this residue which subsides from the hot decoction on cooling.

Another species of extracts is the inspissated juices of plants. Several powerfully medicinal plants, such as the hemlock, are succulent vegetables, which, when strongly expressed,

expressed, yield a large quantity of a green turbid juice, which (after separating the mere fragments of the plant) only requires to be inspissated by a very gentle heat, to form the extract in the form in which it is used.

All the extracts, except those made by alcohol, are liable to spoil by keeping. This is particularly the case with the inspissated juice of the succulent plants, being composed of materials all extremely liable to fermentation, and being kept in a constant tendency to deliquescence by the neutral acetites which they contain. Therefore they must be kept in close vessels, but with every care the most important of them lose their medicinal quality in no great length of time.

EXTRACT, in *Matters of Literature*, denotes a short abridgment of a book or paper, or of some of the matters thereof. The journals, nouvelles, bibliothèques, mémoires, and other monthly reviews, or quarterly accounts of the affairs of learning, consist principally of extracts of the most material passages, doctrines, &c. found in the several books published in that time.

EXTRACT *ab Ecclesia*. See RESTITUTIONE *Extracti*.

EXTRACTA CURIÆ, in our *Old Writers*, the issues or profits of holding a court, arising from the customary fees, &c.

EXTRACTION, in *Pharmacy and Chemistry*, an operation, whereby essences, tinctures, &c. are drawn from natural bodies. See EXTRACT.

EXTRACTION, in *Surgery*, is the drawing from, or out of the body, any thing fixed in it, as a thorn, or bullet, in the flesh, a tooth from the jaw, &c. Surgeons speak also of the extraction of a stone from the bladder, a cataract from the eye, foreign bodies from the œsophagus, extraneous substances from wounds, &c. For a description of the methods of extracting a stone from the bladder, see LITHOTOMY.

The operation of extracting the cataract is explained in the article CATARACT.

EXTRACTION, or *Descent*, in *Genealogy*, denotes the stock, or family, which a person is descended from.

In some military orders, chapters, &c. a candidate must make proof of the nobility of his extraction before he is admitted.

EXTRACTION of *Roots*, the method of finding the roots of given numbers, or quantities. See ROOT.

The square, cube, and other powers of a number, or root, are formed by multiplying the given number into itself a greater or less number of times, as the power required is higher or lower. See POWER.

This multiplication compounds the powers; and the extraction of the roots decomposes them again, or reduces them to their principles or roots. So that the extraction of the root is to the multiplication of the power, what the analysis is to the synthesis.

Thus, 4, multiplied by 4, produces 16; which is the square of 4, or the factum of 4, by itself; and 16 multiplied by 4, makes 64, which is the cube of 4, or the factum of 4 by its square. Such is the composition of powers.

Again, the square root of 16 is 4, because 4 is the quotient of 16 divided by 4; and the cube root of 64 is likewise 4, as 4 is the quotient of 64 divided by the square of 4. Such is the extraction of roots.

Hence to extract the root out of a given power, is the same thing as to find a number, *e. gr.* 4, which being mul-

tipled a certain number of times into itself, produces the given power, *e. gr.* 16 or 64.

For the extraction of square and cube roots, it is necessary to have the squares and cubes of all the digits in readiness; as exhibited in the following table.

Roots	1	2	3	4	5	6	7	8	9
Square	1	4	9	16	25	36	49	64	81
Cube	1	8	27	64	125	216	343	512	729

To extract the square root out of a given number.—1. Divide the given number into classes, of two figures a-piece; and include each class between two dots, commencing with the place of units, and proceeding to the left in integers, and to the right in decimals; the root will consist of so many parts or figures as you have classes. By the way observe, it may happen, that for the last class on the left hand there shall be only one figure left.

2. Then the left-hand class being the square of the first figure of the root sought, look in the table of roots for the square root answering to that number; or, if that square number be not precisely there, to the next lesser number: this root write down for the first figure of the quotient; and subtract its square from the left-hand class. To the remainder bring down the next class toward the right.

3. Write down the double of the quotient figure under the left-hand figure of the second class; and seek how oft this double is contained in the figure over it: the quotient gives the second figure of the root.

4. Write the same quotient under the right-hand figure of the same class, and subtract the product of the whole number underwritten, multiplied by the second figure of the root, from the number over it, as in division.

5. The operation being repeated according to the third and fourth steps, *i. e.* the remainder being still divided by the double of the root as far as extracted; and from the remainder subtract the product of the last divisor, having the last found figure of the quotient added to it, multiplied by this figure, you will have the root required.

*E. gr.* To extract the root of 99856; point it after the following manner, 99856̇: then seek a number, whose square shall equal the first figure 9, *viz.* 3, and write it in the quotient; then having subtracted from 9, 3 × 3, or 9, there will remain 0; to which set down the figures as far as the next point, *viz.* 98, for the following operation. Then, taking no notice of the last figure 8, say, How many times is the double of 3, or 6, contained in the first figure 9? Answer, 1. Wherefore, having written 1 in the quotient, subtract the product, of 1 × 61, or 61 from 98, and there will remain 37, to which connect the last figures 56, and you will have the number 3756, in which the work is next to be carried on. Wherefore, also neglecting the last figure of this, *viz.* 6, say, How many times is the double of 31, or 62, contained in 375 (which may be guessed at from the initial figure 6 and 37, by taking notice how many times 6 is contained in 37)? Answer 6; and writing 6 in the quotient, subtract 6 × 626, or 3756, and there will remain 0; whence it appears, that the business is done, the root coming out 316.

Otherwise,

$$\begin{array}{r}
 99856 \overline{) 316} \\
 \underline{9} \phantom{00} \\
 098 \phantom{00} \\
 \underline{61} \phantom{00} \\
 3756 \phantom{00} \\
 \underline{3756} \\
 0
 \end{array}$$

# EXTRACTION.

Otherwise, with the divisors set down, it will stand thus :

$$\begin{array}{r}
 99856 \text{ (316)} \\
 \underline{9} \\
 6) 98 \\
 \underline{61} \\
 62) 3756 \\
 \underline{3756} \\
 0
 \end{array}$$

o And so in others.

Again, if you were to extract the square root out of 22178791 :

$$\begin{array}{r}
 22178791 \text{ (4709, 43637, \&c.)} \\
 \underline{16} \\
 617 \\
 609 \\
 \hline
 88791 \\
 84681 \\
 \hline
 411000 \\
 376736 \\
 \hline
 3426400 \\
 2825649 \\
 \hline
 60075100 \\
 56513196 \\
 \hline
 356190400 \\
 282566169 \\
 \hline
 73624231
 \end{array}$$

First having pointed it, seek a number, whose square (if it cannot be exactly equalled) shall be the next less square (or nearest) to 22, the figures to the first point, and you will find it to be 4. For  $5 \times 5$ , or 25, is greater than 22; and  $4 \times 4$ , or 16, is less; wherefore 4 will be the first figure of the root. This, therefore, being writ in the quotient, from 22 take the square  $4 \times 4$ , or 16; and to the remainder 6, adjoin the next figures 17, and you will have 617; from whose division, by the double of 4, you are to obtain the second figure of the root, viz. neglecting the last figure 7, say, how many times is 8 contained in 61? Answer, 7; wherefore write 7 in the quotient, and from 617 take the product of 7 into 87, or 609, and there will remain 8, to which join the two next figures 87, and you will have 887; by the division whereof by the double of 47, or 94, you are to obtain the third figure; in order to which say, how many times is 94 contained in 88? Answer, 0; wherefore write 0 in the quotient, and adjoin the two last figures 91, and you will have 88791, by whose division by the double of 470, or 940, you are to obtain the last figure; viz. say, how many times 940 in 8879? Answer, 9; wherefore write 9 in the quotient, and you will have the root 4709. But since the product  $9 \times 9409$ , or 84681, subtracted from 88791, leaves 4110, the number 4709 is not the root of the number 22178791 precisely, but a little less.

If then it be required to have the root approach nearer, carry on the operation in decimals, by adding to the remainder two cyphers in each operation. Thus, the remainder 4110, having two cyphers added to it, becomes 411000; the division whereof, by the double of 4709, or 9418, will give the first decimal figure 4. Then having writ 4 in the quotient, subtract  $4 \times 94184$ , or 376736, from 411000, and there will remain 34264. And so having added two more cyphers, the work may be carried on at pleasure, the root at length coming out 4709, 43637, &c.

But when the root is carried on half way or above, the rest of the figures may be obtained by division alone: as

in this example, if you have a mind to extract the root to nine figures, after the five former 4709,4 are extracted, the four latter may be had, by dividing the remainder by the double of 4709,4.

Thus if the root of 32976 were to be extracted to five places, in numbers; after the figures are pointed, write 1 in the quotient, as being the figure of whose square  $1 \times 1$ , or 1, is the greatest that is contained in 3, the figure to

$$32976 \text{ (181,59)}$$

$$\begin{array}{r}
 1 \\
 \hline
 2) 229 \\
 \underline{224} \\
 36) 576 \\
 \underline{361} \\
 362) 215(59, \&c.
 \end{array}$$

the first point; and having taken the square of 1 from 3, there will remain 2; then having set the two next figures, viz. 29, to it (viz. to 2,) seek how many times the double of 1, viz. 2, is contained in 22, and you will find indeed that it is contained more than ten times; but you are never to take your divisor 10 times, nor even 9 times in this case;

because the product of  $9 \times 29$ , or 261, is greater than 229, from which it would be to be taken, or subtracted; wherefore write only 8. And then having written 8 in the quotient, and subtracted  $8 \times 28$ , or 224, there will remain 5; and having set down to this the figures 76, seek how many times the double of 18, or 36, is contained in 57, and you will find one, and so write 1 in the quotient; and having subtracted  $1 \times 361$ , or 361, from 576, there will remain 215. Lastly, to obtain the remaining figures, divide this number 215, by the double of 181, viz. 362, and you will have the figures, 59 which, being writ in the quotient, give the root 181,59. After the same manner are roots extracted out of decimal numbers. Thus the root of 329,76 is 18,159; and the root of 3,2976 is 1,8159, and the root of 0,032976, is 0,18159, and so on. But the root of 3297,6 is 57,4247; and the root of 32,976 is 5,74247. And thus the root of 9,9856 is 3,16.

To extract the other, or higher root, out of a given number.

—The extraction of the cubic root, and all other roots, may be comprehended under one general rule; viz. every third figure, beginning from unity, is first to be pointed, if the root to be extracted be a cubic one; or every fifth, if it be a quadrato-cubic (or of the fifth power;) and then such a figure is to be writ in the quotient, whose greatest power (that is, whose cube, if it be a cubic power, or whose quadrato-cube, if it be the fifth power, &c.) shall either be equal to the figure, or figures, before the first point, or next less under them; and then having subtracted that power, the next figure will be found by dividing the remainder augmented by the next figure of the resolvend, by the next least power of the quotient multiplied by the index of the power to be extracted, that is, by the triple square, if the root be a cubic one; or by the quintuple biquadrate, (that is, five times the biquadrate,) if the root be of the fifth power, &c. And having again subtracted the power of the whole quotient from the first resolvend, the third figure will be found by dividing that remainder, augmented by the next figure of the resolvend, by the next lesser power of the whole quotient, multiplied by the index of the power to be extracted.

Thus, to extract the cube root of 13312053, the number is first to be pointed after this manner, viz. 13312053 then you are to write the figure 2, whose cube is 8, in the first place of the quotient, as that which is the next lesser

# EXTRACTION.

lesser cube to the figure 13, (which is not a perfect cube number) or as far as the first point; and having subtracted that cube, there will remain 5; which being augmented by the next figure of the resolvent 3, and divided by the triple square of the quotient 2, by seeking how many times 3 x 4, or 12, is contained in 53, gives 4, or the second figure of the quotient. But since the cube of the quotient 24, viz. 13824, would come out too great to be subtracted from the figures 13312, that precede the second point, there must only 3 be writ in the quotient; then the quotient 23 being in a separate place multiplied by 23, gives the square 529, which again multiplied by 23, gives the cube 12167; and this taken from 13312, will leave 1145, which augmented by the next figure of the resolvent 0, and divided by the triple square of the quotient 23, viz. by seeking how many times 3 x 529, or 1587, is contained in 11450, gives 7, for the third figure of the quotient. Then the quotient 237, multiplied by 237, gives the square 56169, which again multiplied by 237, gives the cube 13312053; and this taken from the resolvent, leaves 0. Whence it is evident, that the root sought is 237.

So also, to extract the quadrato-cubical root of 36430820, it must be pointed over every fifth figure; and the figure 3, whose quadrato-cube, or fifth power 243, is the next lesser to 364, viz. to the first point, must be writ in the quotient. Then the quadrato-cube 243 being subtracted from 364, there remains 121, which augmented by the next figure of the resolvent, viz. 3, and divided by five times the biquadrate of the quotient, viz. by seeking how many times 5 x 81, or 405, is contained in 1213, gives two for the second figure. That quotient 32 being thrice multiplied by itself, makes the biquadrate 1048576; and this again, multiplied by 32, makes the quadrato-cube 33554432, which, being subtracted from the resolvent, leaves 2876388. Therefore 32 is the integral part of the root but not the true root; wherefore, if you have a mind to prosecute the work in decimals, the remainder, augmented by a cypher, must be divided by five times the aforesaid biquadrate of the quotient, by seeking how many times 5 x 1048576, or 5242880, is contained in 28763880, and there will come out the third figure, or the first decimal 5. And so by subtracting the quadrato-cube of the quotient 32,5, from the resolvent, and dividing the remainder by five times its biquadrate, the fourth figure may be obtained. And so on *in infinitum*.

In some cases it is convenient only to indicate the extraction of a root, especially where it cannot be had exactly. Now, the sign or character whereby roots are denoted, is  $\sqrt{\quad}$ ; to which is added, the exponent of the power, if it be above a square, and even sometimes if it be not. *E. gr.*  $\sqrt{\quad}$  denotes the square root;  $\sqrt[3]{\quad}$  the cube root, &c. See **Root**.

When a biquadratic root is to be extracted, you may extract twice the square root, because  $\sqrt[4]{\quad}$  is as much as  $\sqrt{\quad} \times \sqrt{\quad}$ . And when the cubo-cubic root is to be extracted, you may first extract the cube root, and then the square root of that cube root, because the  $\sqrt[6]{\quad}$  is the same as  $\sqrt[3]{\quad} \times \sqrt[2]{\quad}$ ;

whence some have called these roots, not cubo-cubic ones but quadrato-cubes. And the same is to be observed in other roots, whose indices are not prime numbers.

To prove the extraction of roots.—1. For a square root; multiply the root found by itself, and to the product add the remainder, if there were any: if the sum be equal to the number given, the operation is just.

2. For a cube root. Multiply the root found by itself, and the product, again, by the same root. To the last product, add the remainder, if there were any. If the sum come out the number first given, the work is just.

After the like manner may the extraction of the other roots be proved.

To extract the roots of equations, or algebraic quantities.—The extraction of roots out of simple algebraic quantities, is evident, even from the nature, or marks of notation itself; as that  $\sqrt{aa}$  is  $a$ , and that  $\sqrt{aacc}$  is  $ac$ , and that  $\sqrt{9aacc}$  is  $3ac$ ; and that  $\sqrt{49a^2xx}$  is  $7aax$ .

And also that  $\sqrt{\frac{a^2}{cc}}$ , or  $\frac{\sqrt{a^2}}{\sqrt{cc}}$  is  $\frac{aa}{c}$ , and that  $\sqrt{\frac{a^2bb}{cc}}$  is  $\frac{aab}{c}$ , and that  $\sqrt{\frac{9aazz}{25bb}}$  is  $\frac{3az}{5b}$ , and that  $\sqrt{\frac{8b^6}{27a^3}}$  is  $\frac{2bb}{3a}$ , and that  $\sqrt[4]{aabb}$  is  $\sqrt{ab}$ ;

moreover, that  $b\sqrt{aacc}$ , or  $b$  into  $\sqrt{aacc}$ , is equivalent to  $b$  into  $ac$ , or  $abc$ ; and that  $3c\sqrt{\frac{9aazz}{25bb}}$  is equivalent to  $3c \times \frac{3az}{5b}$ , or  $\frac{9acz}{5b}$ . And that  $\frac{a+3x}{c} \sqrt{\frac{4b^2x^2}{81aa}}$  is equivalent to  $\frac{a+3x}{c} \times \frac{2bx}{9a}$ , or to  $\frac{2abxx+6bx^3}{9ac}$ .

If say all these are evident, because it will appear at first sight, that the proposed quantities are produced, by multiplying the roots into themselves (as  $aa$  from  $a$  into  $a$ ;  $aacc$  from  $ac$  into  $ac$ ;  $9aacc$  from  $3ac$  into  $3ac$ , &c.) The rule is to extract the required root of the numeral coefficient, if there be any, and to divide the exponents of the literal or algebraic quantities by the number that denominates the root required. It is evident from the application of this rule, that any power which has a positive sign may have either a positive or negative root, if the root is denominated by an even number, because  $+$  or  $-$ , multiplied into themselves an even number of times will give  $+$ . Also, that if a power have a negative sign, no root of it denominated by an even number can be assigned. But if the root to be extracted is denominated by an odd number, the sign of the root will be the same as the sign of the given quantity whose root is required. However, it will often happen, that the number, denominating the required root, will not exactly divide the exponent of the given power, in which case the required root will have a fractional exponent, thus,  $\sqrt[3]{8a} = 2a^{\frac{2}{3}}$ . But when quantities consist of several terms, the business is performed as in numbers.

Thus, to extract the square root out of  $aa + 2ab + bb$ ; in the first place, write the root of the first term  $a$ , viz.  $a$ ; in the quotient; and having subtracted its square  $a \times a$ , there will remain  $2ab + bb$  to find the remainder of the root by. Say, therefore, how many times is the double of the quotient, or  $2a$ , contained in the first term of the remainder  $2ab$ ? I answer,  $b$  [times]; therefore write  $b$  in the quotient, and having subtracted the product of  $b$  into  $2a + b$ , or  $2ab + bb$ , there

aa + 2ab + bb (a + b  
aa  
—  
0 + 2ab + bb  
+ 2ab + bb  
—  
0 0



this divided by  $3a^2$  will give  $-\frac{x^6}{9a^3}$  for the next term of the quotient, &c. But the roots of quantities of this kind are much more expeditiously obtained by means of the binomial theorem. For the square root of  $a^2 + x^2 = a^2 + x^2)^{\frac{1}{2}}$ ; and  $a^2 + x^2)^{\frac{1}{2}} = a^2)^{\frac{1}{2}} + \frac{1}{2} \times a^2)^{\frac{1}{2}-1} \times x^2 + \frac{1}{2} \times \frac{\frac{1}{2}-1}{2} \times a^2)^{\frac{1}{2}-2} \times x^2)^2 + \frac{1}{2} \times \frac{\frac{1}{2}-1}{2} \times \frac{\frac{1}{2}-2}{3} \times a^2)^{\frac{1}{2}-2} \times x^2)^3, &c. = a^2)^{\frac{1}{2}} + \frac{1}{2} \times a^2)^{-\frac{1}{2}} x^2 + \frac{1}{2} \times -\frac{1}{4} \times a^2)^{-\frac{3}{2}} x^4 + \frac{1}{2} \times -\frac{1}{4} \times -\frac{1}{2} \times a^2)^{-\frac{5}{2}} x^6, &c. = a + \frac{1}{2} \times a^{-1} x^2 - \frac{1}{8} \times a^{-3} x^4 + \frac{1}{16} \times a^{-5} x^6, &c. = (bringing the powers of a from the numerators to the denominators, by changing the signs of their exponents)  $a + \frac{x^2}{2a} - \frac{x^4}{8a^3} + \frac{x^6}{16a^5}, &c.$$

Thus also the cube root of  $a^3 + x^3 = a^3 + x^3)^{\frac{1}{3}}$ ; and  $a^3 + x^3)^{\frac{1}{3}} = a^3)^{\frac{1}{3}} + \frac{1}{3} \times a^3)^{\frac{1}{3}-1} \times x^3 + \frac{1}{3} \times \frac{\frac{1}{3}-1}{2} \times a^3)^{\frac{1}{3}-2} \times x^3)^2 + \frac{1}{3} \times \frac{\frac{1}{3}-1}{2} \times \frac{\frac{1}{3}-2}{3} \times a^3)^{\frac{1}{3}-3} \times x^3)^3, &c. = a^3)^{\frac{1}{3}} + \frac{1}{3} \times a^3)^{-\frac{2}{3}} x^3 + \frac{1}{3} \times -\frac{1}{3} \times a^3)^{-\frac{5}{3}} x^6 + \frac{1}{3} \times -\frac{1}{3} \times -\frac{2}{3} \times a^3)^{-\frac{8}{3}} x^9, &c. = a + \frac{1}{3} \times a^{-2} x^3 - \frac{2}{9} \times a^3 \times x^6 + \frac{5}{81} a^{-8} x^9, &c. = a + \frac{x^3}{3a^2} - \frac{x^6}{9a^5} + \frac{5x^9}{81a^8}, &c. See Maclaurin's Algebra, part i. ch. viii. p. 50, 51. See Root.$

**EXTRACTOR**, in *Midwifery*, an instrument contrived to extract children in cases of difficult births. We have the description of a forceps for extracting children by the head when lodged low in the pelvis of the mother, in the *Medic. Ess. Edinb.* vol. iii. art. 20. See also the abridgment of this book, vol. ii. p. 438, where some alteration is mentioned of this instrument from Giffard's *Midwifery*, and an improvement of it by Mr. Freke. See **FORCEPS**.

**EXTRACTUM CATHARTICUM**, a form of medicine in the London Dispensatory, intended as an equivalent for the *extractum Rudii*, commonly called Rudius's pill, and which is for many reasons a better composition than that pill. It is now called "extractum colocynthidis compositum." See **COLOCYNTHIS**.

**EXTRADOS**, the outside of a vault.

**EXTRANEOUS FOSSILS**, in *Geology*. Adventitious, secondary, or figured fossils, have among them (*see FOSSILS, Extraneous*) those remains and exuvia of organized beings, which are found imbedded in the strata of the earth. Since the discovery of Mr. William Smith, that each particular shell, and other organic remain, has its proper and appropriate place in the lamina of some particular stratum, and of which it is often a perfect, and, perhaps, the most unerring test of identity, in most instances, the knowledge and exact discrimination of these numerous animal and vegetable remains has appeared a matter of the first importance to geologists, especially since it has been further ascertained, as it now is, that most, if not every one, of the organic remains, differ essentially from any recent species of the animals and plants, to which former, and too cursory, observations had referred them; while many of them differ altogether and entirely from any thing now living or growing; which two points ascertained, have tended irresistibly to shew that

these organic remains were not entombed by the Mosaic deluge, as most writers had supposed, because they differ entirely from the antediluvian race, of which the present living ones are the descendants and exact representatives, as the Mosaic account informs us, and are not of subsequent creation. Another result of the former of these facts has been to shew, that the several animals and plants whose fossil remains we meet with in the strata, lived and died on the stratum in which we find them, prior to the deposition, and, perhaps, prior also to the creation of the matter of the lamina which covers them; and that the period of the existence of particular species was in most, if not every instance, limited to that took up in the deposition of the particular stratum in which they are found imbedded, seeming to suggest, that they were *created* at the period of the stratification, which answers to the lowest lamina in which they are found, and ceased to exist altogether at the period answering to the highest lamina in which they are found; a supposition in no ways inconsistent with the Mosaic account of creation, if the whole of the fossil race be different from the present race of organized beings, and of a period of time antecedent to the events described by the sacred historian, except in his introductory words, "In the beginning God created the heavens and the earth." It may, possibly, be urged, against the idea of a temporary duration of the primitive animals and plants, and their becoming after that *extinct*, that the same kind of organic remains are found again, after large successions of depositions with remains of different beings, in ascending the series of strata, or in very distant parts of the globe; to which it may be answered, that where sufficient discrimination has been made in the specific differences of organic remains resembling each other, but found imbedded in a strata separated by those of a different kind, and with different kinds of organic beings in them, it has generally, if not always, turned out, that the remains resembling each other, and hitherto supposed identic, are in reality not so, but of perfectly distinct species, their *varieties*, as some might be disposed to call them, in conformity to the language of the naturalists respecting accidental deviations in some recent species, being *constant*, and such as properly constituted distinct species in the great families of the primitive creation. Respecting organic substances found at very distant places on the globe, which, on being brought together and thoroughly examined, appear to be identic; before any argument is drawn therefrom, against the temporary existence and extinction of their originals in the primitive race which inhabited the waters of this globe, it should be distinctly ascertained that the series of strata and organic remains above and below the two places in the series whence the specimens were brought are really different; or, in other words, that the identic species really do belong to different parts of the series of strata: for if, on the contrary, they belong to the *same stratum*, however its obvious mineralogical character may appear changed, it is to be expected that the organic remains will be identic, since Mr. Smith has, on tracing the ending or actual out-crop of a stratum for several hundred miles, always found the organic remains the same; as the numerous specimens in his collection, marked and brought from the extreme and intermediate points of such examination, do testify.

It is also to be taken into consideration, that the discoveries of Mr. Farey, relative to denudated tracts on our globe, shew the possibility, and, perhaps, the frequent occurrence of such deep excavations being left in the strata of the earth, as to exhibit the edges, and indeed considerable tracts of the planes of strata, at immense depths in the series, below those proper to the general strata on the sur-

face, and having their regular basket, or ending, on the surface, at great distances from such denudated exposures of them. The immense denudation, for instance, which has laid bare the fourth or lowest limestone rock of Derbyshire and Staffordshire, and the excavation of Dove-dale and other vallies therein, appears to have exposed strata to view, which are from  $1\frac{1}{2}$  to 2 miles in perpendicular depth beneath the red earth, or gypseous tract, which surrounds them on all sides! (except, perhaps, a narrow strip on the north, along the grand ridge, or waterhead of the island,) which lower exposed parts of the fourth lime rock do not, perhaps, anywhere basket, or come regularly to the surface, within 90 or 100 miles of Dove-dale and other vallies, where the denudation has exposed them. The continents seem, from the relations of travellers, likely to furnish numerous instances of denudations in the mountain chains, which will be found to expose strata that lie very low indeed in the general series, and at very great distances from the regular or continued line of ending or outcrop of those particular strata; and, without adverting to which circumstances, the exact identity of organic remains from distant places so circumstanced, might seem to contradict our ideas of their being peculiar to peculiar strata. But after all, should identically the same species of organic remains be found in distant parts of the series of terrestrial strata, what have we to limit the architect of "heaven and earth," from having re-created similar animals or plants during the countless periods of the primitive creation and existence? Analogy surely cannot be said to do this, when the animals and plants created since he said "Let the waters be gathered together, and let the *dry land* appear," and which still continue to exist, have so many points of resemblance to some of the primitive and extinct ones, both in forms and habits, that they have for ages passed as identic therewith. Mr. James Parkinson and Mr. W. Martin, having engaged in works intended to collect information on, and more accurately to discriminate, extraneous or organic fossil remains, which works are still in progress, and the results of Mr. W. Smith's labours and those of his pupils being yet in a great measure unpublished, we shall defer what we have further to add on these highly interesting and curious relics to the article *RELICUIA*, which seems, indeed, their more appropriate title. In the mean time, as the usual names of the several fossil animals and plants, &c. occur, we shall not fail to lay before our readers such facts and particulars as we can collect, and with propriety communicate, concerning the objects of the unpublished researches of the meritorious individuals alluded to; to whose credit it ought to be known, that extended and undisguised communications have all along been made among the circle of their friends, and in consequence of which a spirit of enquiry on the subject has been excited, in various districts of the kingdom, from which the happiest consequences to science may be expected shortly to arise.

*EXTRANEONS*, *Extraneus*, Lat. belonging to nothing, forcing. This word, during the last century, was admitted into the musical technica, in speaking of an unusual and irregular change of key, which is called extraneous modulation, or modulating into an unrelative key, as in the key of C natural, D with a sharp  $3d$ , D  $b$ , B  $\sharp$ , and B  $b$ , which are unrelative keys, having no found in common with the chord of C natural. With respect to extraneous modulation, Rousseau says that no composers have frequent recourse to sudden and unusual modulation, but those who are sterile in fancy and invention: and we should believe the assertion well founded, if Eman. Bach, Haydn, and Mozart, were excepted, who cannot be accused of want of invention.

It is to the clumsy imitators of these great masters, who, in total want of melody, have recourse to unexpected harmony, that Rousseau's accusation seems to attach.

*EXTRAORDINARIUM*, in *Roman Antiquity*, a body of forces, consisting of a third part of the horse, and a fifth part of the foot, which was separated from the rest, to prevent any design that might be formed against the natural forces. See *ABLECTI*.

*EXTRAORDINARY*, something out of the common course.

*EXTRAORDINARY couriers*, are those sent express on some urgent occasion.

*EXTRAORDINARY ambassador*, or *envoy*, is such a one as is sent to treat or negotiate some special and important affair, as a marriage, a treaty, confederacy, &c. or even on occasion of some ceremony, as condolence, congratulation, &c. See *EMBASSADOR*.

A gazette, journal, or other news-paper extraordinary, is that published after some great and notable event, containing the detail or particulars thereof, which are not found in the ordinary papers. Our news-writers generally use postscripts, or supplements, instead of extraordinary.

*EXTRAORDINARY culverin*. See *CULVERIN*.

*EXTRAVAGANTES*, a part of the canon law, containing divers constitutions of the popes, not included in the body of the canon-law; whence the denomination *extravagantes*: "quasi extra corpus juris vagantes."

The *extravagantes* are divided into two parts: the first contains twenty constitutions of John XXII. and the second other later constitutions of the said John, and his successors. See *CANON-LAW*, and *DECRETALS*.

*EXTRAVASATION*, a term in *Surgery*, derived from *extra*, *out of*, and *vasa*, *the vessels*; it signifies an effusion of any fluid from the vessels, viscus, or receptacle, in which such fluid is naturally contained, and the passage of the same into another situation, which is very frequently the interstices of the cellular membrane. In the head, blood is often extravasated, under the cranium, upon the surface of the dura mater, in consequence of the rupture of one of the arteries of this membrane from external violence. The same fluid is also frequently extravasated on the pia mater, and in the convolutions of the cerebrum, or more deeply in the ventricles, and very substance of the brain.

In cases of wounds of the abdomen, large quantities of blood are occasionally extravasated in the cavity of the peritonæum, or the contents of the stomach, bowels, gall-bladder, or some other injured viscus, may become effused. When the urinary bladder is wounded, or when a slough takes place in a certain part of it, from the distension occasioned by a long protracted, and unrelieved retention of urine, the latter fluid may become extravasated in the abdomen. In the example of strictures, the urethra occasionally ulcerates between the obstruction, and the neck of the bladder, and the urine is consequently extravasated in the cellular membrane of the perinæum and scrotum. Sometimes, when a portion of the bowels mortifies, after being returned into the belly, in cases of hernia, the intestinal matter escapes from the alimentary canal, through the breach occasioned by the sloughing.

In the thorax, surgeons sometimes have opportunities of seeing cases, in which considerable extravasations of blood arise, in consequence of stabs and gun-shot wounds.

In the limbs, and indeed, we might say, in every situation, practitioners frequently meet with extravasations of blood, in cases of wounded arteries, aneurisms, and violent contusions

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contusions and blows, which rupture vessels of important size. Bloody swellings, produced in the last-mentioned manner, are technically named ecchymoses, and have already been treated of elsewhere. See ECCHYMOSES.

Our design, in the present place, is to consider extravasations in a surgical point of view, as they occur in the head, the chest, and the belly; taking occasion, however, to refer the reader for certain parts of the subject to other places in this work.

*Extravasation of blood in the head, from external violence.*—After explaining with equal perspicuity and elegance, how the dura mater serves as a pericorium to the internal surface of the bones of the cranium, in the same manner as the pericranium does to the external table, Mr. Pott notices, that by blows, falls, and other shocks, some of the larger of the vessels, which carry on the communication between the dura mater and the skull, may be broken, and a quantity of blood shed upon the surface of that membrane. This, he observes, is one species of bloody extravasation, and, indeed, the only one which can be formed between the skull and dura mater. If the broken vessels be few, and the quantity of blood which is shed, be small, the symptoms are generally slight, and, by proper treatment, disappear: when they are large, or numerous, or the quantity of extravasated fluid considerable, the symptoms are generally urgent in proportion; but, continues Mr. Pott, whether they be slight, or considerable, whether immediately alarming, or not, they are always, and uniformly, such as indicate pressure made on the brain and nerves, *viz.* stupidity, drowsiness, diminution, or loss of sense, speech, and voluntary motion.

The shock which the head sometimes receives by falls from on high, or by strokes from ponderous bodies, may likewise occasion a breach in some of the vessels, either of the pia mater, or brain, and thus produce an extravasation of the fluid which should circulate through them.

Mr. Pott remarks, that an extravasation may be the only complaint caused by the accident; or it may be joined with, or added to, a fracture of the skull. But, this is not all; for it may be produced not only when the cranium is unhurt by the blow, but, even when no violence of any kind has been offered to, or received by the head.

Vertigo, vomiting, stupidity, hemorrhage, loss of sense and motion, either partial or total, are set down by this celebrated surgical author as the symptoms of an extravasation within the cranium; sometimes one or more occur in the same subject; sometimes all of them. These symptoms, which are all easily accountable for from extravasation of fluid, and unnatural pressure made on the brain and nerves, are, says Pott, frequently mistaken as indications of a disease, which, considered abstractedly, can never cause them; he means a simple undepressed fracture of the cranium, which may be accompanied by them, but cannot cause them.

The same writer repeats, that when a fluid is extravasated in any considerable quantity within the cavity of the cranium, if any bad symptoms are produced by it at all, they are, and must be, such as indicate pressure made on the brain, and origin of the nerves, occasioning thereby either disturbance, or abolition of the offices of sense and motion; and this in a different degree, according to the quantity, kind, and situation of the pressing fluid.

Mr. Pott seems to have entertained the common notion of hemorrhage from the ears and nose being also symptoms of an extravasation. However, the least reflection must soon make any body perceive, that a bleeding from those parts is only indicative of their having sustained a violent shock

in common with the rest of the head. Even the degree of violence is not at all denoted with any certainty by these circumstances; for, with respect to the nose, we know, that, in many persons, the slightest cause will make it bleed.

When the above-mentioned symptoms exist, Mr. Pott was of opinion, that we might pronounce, in a positive manner, our judgment, that the brain suffers compression; but, says he, to our very frequent mortification, we find these are the only circumstances which, in such case, we can depend upon; every thing else which relates, or belongs to them, being involved in a most perplexing obscurity. We not only have no certain infallible rule whereby to distinguish what the pressing fluid is, or where it is situated; but we are, in many instances, absolutely incapable of knowing whether the symptoms be occasioned by any fluid at all; for, a fragment of bone broken off from the internal table of the cranium, and making an equal degree of pressure, will produce exactly the same complaints.

When a case, attended with the preceding symptoms, occurred, the old surgeons used in general to conclude, that the brain had suffered a concussion, to which all the consequences were imputed.

Mr. Pott observes, that a concussion and an extravasation are very distinct causes of mischief, though not always very distinguishable. M. Le Dran, and others of the modern French writers, have made a very sensible and just distinction between that kind and degree of loss of sense, which arises from a mere commotion of the brain, and that which is caused by a mere extravasation, in those instances, in which the time of the attack or appearance of such symptoms, is different, or distinct. The loss of sense, which immediately follows the violence, say they, is most probably owing to a commotion; but, that which comes on after an interval of time is past, is most probably caused by extravasation.

Mr. Pott remarks, that this distinction is certainly just and good, as far as it will go. That degree of abolition, or diminution of sense, which immediately attends, or follows the blow or fall, and goes off again, without the assistance of art, is in all probability occasioned by the sudden shake or temporary derangement of the contents of the head; and the same kind of symptoms recurring again some time after they had ceased, or not coming on until some time has passed from the receipt of the violence, do most probably proceed from the breach of a vessel within, or upon the brain. But, unluckily, we have it not very often in our power to make this exact distinction. An extravasation is often made so immediately, and so largely, at the instant of the accident, that all sense and motion are instantaneously lost, and never again return. And it also sometimes happens (continues Mr. Pott), that, although an extravasation may possibly not have been made at the moment of the accident, and the first complaints may have been owing to commotion merely, yet a quantity of fluid having been shed from its proper vessels very soon after the accident, and producing its proper symptoms, before those caused by the commotion have had time to go off, the similarity of the effects of each of these different causes is such, as to deprive us of all power of distinguishing between the one and the other, or of determining, with any tolerable precision, to which of them such symptoms as remain are really owing.

Mr. Pott next observes, that the nature and degree of the symptoms, produced by the pressure of an extravasation, are various and different in different persons, according to the kind, quantity, and situation of the pressing fluid. Sometimes it is mere fluid blood; sometimes blood in

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a state of coagulation; sometimes it is a clear lymph; and, at others, blood and water are found mixed together; each of these is found either simple or mixed in different situations; that is, between the skull and dura mater, between the dura and pia mater, or in the natural cavities of the brain, called its ventricles, and sometimes, in cases of great violence, they are found at the same time in all these different parts. Sometimes, a considerable quantity is shed instantly at the time of the accident; and sometimes the breach, by which the effusion is made, is so circumstanced, both as to nature and situation, that it is at first very small, and increases by faster or slower degrees. In the former (says Pott), the symptoms are generally immediate and urgent, and the extravasation is of the bloody kind. In the latter, they are frequently slight at first, appear after some little interval of time, increase gradually, till they become urgent, or fatal, and are, in such case, generally occasioned by extravasated lymph. So that although the immediate appearance of bad symptoms does most certainly imply mischief of some kind or other, yet, on the other hand, no man ought to suppose his patient free from hazard, either because such symptoms do not shew themselves at first, or because they appear to be but slight; those which come on late, or, appearing slight at first, increase gradually, being full as much to be dreaded as to consequence as the more immediately alarming ones; with this material difference between them, that the one may be the consequence of a mere concussion of the brain, and may by means of quietude and evacuation go quite off; whereas, the other being most frequently owing to an extravasation of lymph, (though sometimes of blood also,) within the substance of the brain, are very seldom removed by art. (Pott's Works, vol. i.) It appears from some excellent observations published by Mr. Abernethy on the subject of injuries of the head, that a fracture of the skull is not likely to be followed by an equal degree of extravasation in every part, as the vessels, connecting the dura mater to the cranium, are in most parts of that membrane of a small size. If these are accidentally ruptured, a slight hemorrhage ensues, which soon stops, and only a thin stratum of coagulated blood is found, if the bone be removed. But, says Mr. Abernethy, if the fracture happens in the track of the principal artery of the dura mater; if the trunk, or even a considerable branch of that vessel be torn, the hemorrhage will be profuse, and the operation of the trephine becomes immediately necessary to preserve the life of the patient.

When an interval of sense occurs between the blow and the stupor occasioned by the effused blood, the discrimination of the nature of the case is greatly facilitated by that circumstance, as we have already related, because it becomes manifest, that the bad symptoms, which now come on, are not owing to the first mere shock of the external violence on the brain. The patient was most probably stunned by the blow, at the very instant of its occurrence; but he gradually regained his senses, in proportion as the first effects of the shock on the brain subsided. However, as some vessel was wounded by the same blow, an hemorrhage continues under the cranium, on, or within, the brain, and as soon as a certain quantity of blood is extravasated, its pressure produces a recurrence of stupefaction.

Unfortunately, great obscurity attends numerous cases, in consequence of patients having no interval of sense, and remaining in a state of complete stupefaction ever after the accident. We know not, whether the brain is labouring under concussion, or compression, or both; and even when we do know that the bad symptoms arise from an extravasa-

tion, we are frequently unable to say where the effused blood is situated. Now, since the operation of trepanning is not likely to afford assistance, unless the blood be upon the dura mater, so as to allow of being taken away, and since the operation itself is by no means free from danger, we should be very reluctant to put it in practice, without having good foundation for believing that there will be found immediately under the perforation, which we are about to make in the bone, the extravasated blood, which gives rise to the urgent complaints. Practitioners are highly indebted to Mr. Abernethy for a suggestion, which promises to be of exceedingly great assistance in directing whether the trephine ought to be used, or not, on a particular part of the head. "Unless one of the large arteries of the dura mater be wounded, (says this gentleman,) the quantity of blood poured out will be inconsiderable; and the slight compression of the brain, which this occasions, may not be attended with any peculiar symptoms; or, perhaps, it may occasion some stupor, or excite an irritation disposing the subjacent parts to become inflamed; but both these effects will gradually abate, nor will any inflammation ensue, if proper means are taken to prevent it. It is indeed highly probable that in many cases, which have done well without an operation, such an extravasation has existed. But, if there be so much blood on the dura mater as materially to derange the functions of the brain, the bone, to a certain extent, will no longer receive blood from within; and by the operation performed for its exposure, the pericranium must have been separated from its outside. I believe, that a bone so circumstanced will not be found to bleed; and I am certain it cannot with the same freedom and celerity, as it does when the dura mater remains connected with it internally."

In some cases, related by Mr. Abernethy, there was not the least hemorrhage, and this gentleman mentions his having twice been able, by attending to the want of hemorrhage from the outside of the cranium, to ascertain the extent to which the dura mater was detached within. Also, when symptoms seemed to require the perforation of the skull, Mr. Abernethy has frequently seen the operation contra-indicated by the hemorrhage from the bone, and rightly, as the event proved.

When the bone has been for some time bare, this criterion may not be so clear; but Mr. Abernethy scraped the surface of a portion of the skull, which had remained some time in a denuded state, and he found that it bled freely enough to denote that the dura mater was adherent to the inner table, and, consequently, that making a perforation there could be of no service. See *Essay on Injuries of the Head*, p. 32—34.

We shall next enumerate the symptoms of pressure on the brain, and contrast them with those of concussion. It is to be understood, that the complaints produced are nearly the same, whether the pressure is made by an extravasation, or a fracture of the cranium with depression.

### *Symptoms of Pressure.*

1. Patient at first stunned, with cold extremities.
2. Revives, and has an interval of sense, in cases of extravasation, but not in those of a depressed fracture.
3. The quantity of effused blood increasing, he becomes drowsy and stupid.
4. Pulse regular and slow.
5. Patient quite insensible.
6. Pupil dilated.
7. Stertorous respiration.

N.B. When the bleeding is very copious in the first instance,

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ance, or when a violent concussion of the brain has also happened, the patient has no interval of sense.

### *Symptoms of Concussion.*

- |               |   |
|---------------|---|
| First stage.  | <ol style="list-style-type: none"> <li>1. Patient at first stunned.</li> <li>2. Extremities cold; pulse hardly perceptible.</li> <li>3. When the violence has not exceeded a certain degree, the senses return gradually.</li> <li>4. The stomach rejects its contents; sickness betrays irritability in the œsophagus and stomach, and cannot be expected, when the brain is labouring under much compression, the great effect of which is to produce an universal insensibility, or palsy, throughout the body.</li> <li>5. The pulse is now slow, and intermits.</li> </ol> |
| Second stage. | <ol style="list-style-type: none"> <li>6. In proportion as the immediate effects of the shock of the brain subside, symptoms of irritation and inflammation of that organ come on.</li> <li>7. Symptomatic inflammatory fever begins.</li> <li>8. Pupil of the eye contracted.</li> <li>9. The vessels of the eye become red and turgid.</li> <li>10. Delirium.</li> <li>11. Pulse very frequent and small.</li> </ol>  |

We shall not expatiate on this subject; but refer to COMPRESSION, CONCUSSION, INJURIES of the HEAD, and TREPANNING, for further information.

*Extravasation of blood in the thorax.*—In cases of wounds which penetrate the cavity of the chest, the intercostal arteries are liable to be injured, and if the blood cannot readily flow outward through the wound, it is apt to insinuate itself between the pleura and lungs. An extravasation of blood may also occur in the thorax, when some of the vessels of the lungs, one of the coronary arteries of the heart, or the internal mammary artery, have been wounded. An effusion of blood in the chest may likely obviously originate from a wound of the auricles, or ventricles of the heart, or of the thoracic aorta, and vena cava; but we need hardly observe, that in these and other instances, in which the bleeding would be in a moment excessively profuse, the extravasation proves instantly fatal. Smaller vessels are frequently injured, and pour out a considerable quantity of blood in the chest; yet the records of surgery evince, that these accidents do not always have a fatal termination.

The symptoms commonly enumerated by surgical writers, as indicative of an extravasation of blood in the thorax, are the following: the patient is greatly oppressed, and experiences a kind of uneasiness which will not let him remain for any length of time in the same posture. He feels considerable difficulty in sitting up in bed, except his body be bent a good way forward, in which position the diaphragm is relaxed, and not so much dragged by the weight of the extravasated fluid. When the thighs are bent, the patient can lie with tolerable ease on his back, he is also not averse to lying on the side on which the wound is situated; but he cannot place himself on the opposite one, without feeling very acute pain in the situation of the mediastinum.

His respiration is short, frequent, and interrupted by sighs; his veins become empty, a mortal paleness spreads over his countenance; his extremities become cold; a viscid perspiration covers his neck and temples; his teeth chatter,

his pulse grows weak, and if (as most frequently happens) the lungs are wounded, he coughs up frothy blood, and air issues from the wound.

The preceding class of symptoms, however, are not always attendant on every considerable effusion of blood in the thorax. Wounded persons have been known to die of such an extravasation, whose respiration was tolerably free, and who did not complain of suffering more inconvenience in one posture than another. Sabatier states, that several facts of this kind have fallen under his own observation. Other wounded persons also, who have had most of the complaints, usually imputed to extravasations of blood in the thorax, have been cured by ordinary means.

The symptoms of an extravasation of blood in the thorax are upon the whole very equivocal. Hence; several attentive practitioners have taken extraordinary pains to discover additional circumstances, by which the nature of the case might be more infallibly ascertained. These endeavours, however, seem to have been attended with little success. A surgeon of the name of Valentine asserted, that a sort of ecchymosis of the integuments, over the angles of the ribs, was an invariable symptom; but succeeding observers have not found the remark correct.

When there is no doubt in the practitioner's mind that blood is extravasated in the cavity of the thorax, and that it is the occasion of a dangerous oppression of the lungs and diaphragm, the obvious indication is to endeavour to promote the escape of the effused fluid. However, before undertaking any operation, the revived state of the pulse, the return of warmth in the extremities, and the cessation of convulsions ought to denote, that the hemorrhage no longer continues from the wounded vessels. If vent were given to the extravasation before the bleeding had ceased, a fresh quantity of blood would soon be poured out in the chest, and the patient die exhausted.

For another reason, also, prudence requires that the practitioner should not precipitately have recourse to an operation: *viz.* allowing a little while gives nature an opportunity of employing her own resources, and any one who will be at the trouble of referring to books of surgical cases, will soon meet with examples in which there is every reason to believe that there was more or less blood extravasated in the chest, though the patients completely recovered without any operation.

There are five principal methods of discharging blood from the cavity of the chest. 1. By placing the patient in a posture which favours the escape of the blood. 2. By introducing a syringe for the purpose of sucking it out, or a mere cannula, through which it is to flow. 3. By enlarging the wound. 4. By employing injections, with which the clots of blood are to be washed away. 5. By making an opening into the thorax in a depending situation.

Having thus cursorily treated of extravasations in the chest, we shall quit the subject for the present, intending to resume the consideration of it in speaking of wounds of the thorax. See WOUNDS.

For an explanation of the method of making a depending opening into the chest, see PARACENTESIS.

*Extravasations in the Abdomen.*—Various kinds of fluids may be extravasated in the abdomen in cases of wounds, sloughing of the intestines, &c. Bile, chyle, urine, blood, feces, &c. are all apt to be effused under particular circumstances. Surgeons used formerly to suppose, that whenever any fluid escaped from a vessel, or bowel, into the general cavity of the peritonæum, it always became extensively diffused among the convolutions of the intestines. The erroneous supposition seemed to be con-

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formed by facts, the most open to observation, and completely exempt from the possibility of mistake. Practitioners saw that the water of dropsies, the pus of abscesses, which had burst into the abdomen, as well as the chyle and feces, which had escaped through a wound, or other sort of breach of an intestine, were invariably and universally diffused among the folds of the mesentery and bowels after death.

M. Petit (the son) first questioned the accuracy of the foregoing opinion, in relation to the patient while alive. He suggested that as in the living body the intestines were distended with feces, alimentary matter and air, while they were also mutually acting against each other, and in a continual state of compression from the alternate contraction of the diaphragm and abdominal muscles, there might be a superior resistance made to the weight of the extravasated fluid tending to separate the viscera to which we allude. On the contrary, says Petit, is it not possible that, as soon as the patient is dead, and the above kind of resistance is taken away, the extravasated fluid may insinuate itself any where without difficulty? M. Petit remarks, that the truth of the preceding suggestion cannot be doubted, when we consider, that certain cases of hernia get well, notwithstanding the bursting of the gangrenous part of the intestine, after its reduction into the abdomen. In such instances, in fact, the contents of the bowels appear to escape outward through the wound entirely in consequence of the resistance made to their diffusion among the convolutions of the intestines. However it might be objected, that, in cases of hernia, since the bowel is almost always adherent to the edge of the abdominal ring, the issue of the intestinal matter through the wound is rather to be ascribed to the ease with which this event may happen, than to any resistance made internally by the surrounding viscera. But M. Petit cites several cases, which fully confirm, that there is a vast resistance made to the lodgment of extravasated fluids among the convolutions of the bowels, and folds of the mesentery.

After death, any fluid, extravasated in the abdomen, may by its mere gravity insinuate itself any where, and become dispersed among the various parts, because these parts being without action make no opposition. But in the living state, all the abdominal viscera reciprocally act upon each other, and forming, as it were, only one body, by reason of such mutual support, the resistance which is made to any extravasated matter will always keep it from becoming widely diffused, in the manner which many have imagined.

Let us next, with M. Petit, reflect upon the inferences to be drawn from such reciprocal action of the abdominal viscera.

The first consequence is, that an extravasated fluid can only insinuate itself into the cavity of the abdomen, in the same way that a fluid becomes effused in an external part; that is to say, the extravasation can only spread by degrees, and successively, into such places as offer the least resistance. Blood, when it insinuates itself into the interstices of the muscles, can only get from one membranous cell into another, by the first one being so distended, that the fluid can more readily get into a second cell, and from this into a third, than increase the distended state of its first situation. Just so in the abdomen, the blood which escapes from a wounded vessel, is first effused into a situation near the opening in the vessel, either between the peritonæum and surface formed by the intestines, or more deeply among the convolutions of the bowels, or some of the folds of the mesentery. In the proportion as the bleeding continues, the blood forces its original boundary, and dilates the place which it occupies, in every direction, until it meets with less resistance in making its way, either upward or downward, or to the

right or left. The extravasation continues to dilate the new space, which it fills in the same way, until either the first limits are forced, or the effused fluid spreads in some other direction. The extravasation will expand in this manner, till the resistance, made by the viscera, becomes equal to the impetus, with which the blood issues from the vessel. M. Petit was of opinion, that it was this kind of resistance which put a stop to the hemorrhage, even before any coagulum had been formed in the opening of the vessel. That the blood, while flowing from the vessel and in a fluid state, should only make one mass and be contained in one cavity, till coagulation takes place, is a circumstance which cannot rationally be imputed to any thing else, than the resistance depending upon the mutual action of the viscera in the living state. It is also equally certain, that it is in consequence of the sudden cessation of such resistance, that extravasated blood, which is fluid after death, becomes dispersed among the different convolutions of the bowels, and forms numerous scattered collections.

The second inference which M. Petit mentions, as deducible from the resistance arising from the reciprocal pressure of the abdominal viscera, is that an extravasation in the cavity of the abdomen cannot so easily happen, as some have fancied. It was once not an uncommon idea, that a breach in a very moderate vessel could occasion a considerable extravasation, because the orifice could not be compressed, like that of a vessel in a more external situation. It is indeed true, that no compression can be directly applied to the opening in an internal vessel; but the resistance which the surrounding viscera make to the extravasation, operates as a substitute. It is even probable, according to Petit, that when blood is effused in the abdomen, it has a greater resistance to overcome, than when extravasated in an external part. This author states, that the resistance of the cellular membrane, the common bond of connection between the muscles, is undoubtedly less than that which depends on the reciprocal action of the intestines, and rest of the viscera. The incessant alternate motion of the abdomen and thorax is in favour of the preceding opinion. The facility also, with which abscesses situated in the abdomen are discharged, through a small, and very frequently not a depending opening, is an additional fact, proving that the abdominal viscera, by the manner in which they mutually press upon each other, make a greater resistance to an extravasation, than can be made by the cellular substance in other parts of the body.

Swords have often been thrust completely through the body, without giving rise to any dangerous symptoms, or only to such as frequently attend wounds, which do reach into the cavity of the belly. We cannot imagine, contrary to all probability, that, in this case, the weapon has slipped over the intestines, through their interstices, and by good luck has wounded none of the blood-vessels. We must rather conclude, that an extravasation does not always ensue from a wound of the viscera or blood-vessels, or at least, that the extravasation is not invariably attended with such consequences as former practitioners used to suppose.

For the purpose of rendering the foregoing remarks more intelligible, let us follow M. Petit in his observations, and take notice of the principle which he has laid down in his excellent memoir, *viz.* that without a particular action in the muscular fibres of the intestine or artery, no extravasation would occur in the abdomen, even were there a breach in such bowel or vessel. Supposing the blood vessels destitute of action, and the place of the opening pressed upon by a force equal to that, which operates upon the rest of their extent, the fluid, which they contain, would never

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be effused in the abdomen, so as to form an extravasation. Besides its being evident, that this must be the fact, M. Petit mentions his having actually observed it in the body of a man, who died of gangrene in the abdomen, in consequence of a hernia, which was attended for upwards of a fortnight with the most violent symptoms of strangulation. Nearly the whole of the intestinal canal was equally affected with gangrenous mischief, so that it was scarcely possible to handle any of the bowels without occasioning a breach in them. However, although the intestines were filled with very fluid excrement, none of it was extravasated in the abdomen. In several places, indeed, Petit discovered numerous little breaches of continuity, which had allowed a little of the excrement to escape, but only just enough to tinge the adjacent parts. Petit acknowledges, at the same time, that round where these holes were situated, some slight adhesions had taken place between the bowels, and these and other parts; but they were so weak, and easily broken, as to be quite incapable of hindering an extravasation. Petit concludes, that in this instance no extravasation happened, because the intestinal canal was every where affected with gangrene in nearly the same degree, and the disease had destroyed the tone and action of the muscular fibres of the intestines.

It is contended by Petit, that the foregoing case affords sufficient proof, that, without a contractile power in the blood vessels and intestines, no extravasation of their contents could be produced in the abdomen, and that such an event would certainly be opposed by the action of the abdominal muscles and diaphragm, which make uniform and equal pressure upon all the viscera. If this statement be correct, it is obvious, first, that the greater the action of the wounded vessels is, in relation to the quantity of fluid which they have to propel, the greater will be an extravasation from them: secondly, that no extravasation can arise unless the action of the vessels themselves be capable of overcoming the resistance depending upon the mutual action of the parts. Hence, only wounds of vessels above a certain size can give rise to extravasations; at least, to any of importance. The veins cannot occasion so much extravasation as the arteries: nor are wounds of the intestines so apt to be followed by an effusion of the chyle and feces, as the same injuries of the blood vessels are liable to be attended with an extravasation of blood. Petit was also of opinion, that wounds of the stomach were not so often as those of the bowels the cause of this kind of accident.

The feces cannot be so easily extravasated as blood, not only because the action of the intestines, particularly that of the small ones, upon their contents, is weaker than that of the blood vessels upon the blood, but, principally, because, when there is a breach in one of the bowels, the contents will continue their course through the intestinal canal, without any need of there being a considerable obstacle to the occurrence of an effusion. However, Petit admonishes us not to conclude, from what has been said, that the chyle and feces can never be extravasated in the abdomen. There is no doubt whatever, he observes, that an extravasation may take place, when the wound in the bowel is of ample size, the gut filled with chyle or excrement, and care is not taken to empty the large intestines very often with glysters. The event may also happen, when pain and irritation render the muscular action of the intestines violent, irregular, and convulsive, and when unequal pressure is made upon the abdomen. Under such circumstances, the resistance made to an extravasation, by the reciprocal action of the viscera, is overcome, and the contents of the bowels will continue to be effused, until the impulse arising from the contractile power

of these organs returns to a state of equilibrium with the resistance depending on the mutual action of all the viscera.

The extravasation of chyle and feces does not take place differently from that of blood; but in wounds of the bowels there is this advantage, that the same opening which has given passage to the extravasated fluid, may also allow it to return and pass off. Petit remarks that we need no further proof of what has been stated, than the great evacuations of blood, which some wounded persons have had with their stools, without being afflicted with any of the symptoms of extravasation. It is highly improbable, that such bleeding could depend upon the injury of any of the vessels ramifying upon the intestinal canal, since their size is too inconsiderable. We rather believe that, in these cases, some vessels, either of the mesentery, or some other part, have been wounded at the same time as the intestine, and that the blood has insinuated itself into, and taken its course through the bowels, in consequence of the resistance made to its extravasation among the viscera.

The foregoing remarks, made by Petit (the son), clearly prove not only that an extravasation of feces cannot so easily happen in the abdomen as has been imagined; but, also, that it is less dangerous than an effusion of blood usually is, and that it is accompanied by less violent symptoms. When the contents of the bowels are extravasated, adhesions are likewise observed to form more readily, and to limit the effused matter sooner, than when the extravasation consists of blood. After such adhesions have once formed, it is probable that the extravasated matter may be got rid of in the same favourable way, as certain abscesses, which have discharged themselves into the intestinal canal. Blood, however, cannot insinuate itself again into the canal of the vessel, out of which it has escaped, because a clot blocks up the opening. But a wound in an intestine remains continually open, till it is closed by the adhesions which the bowel contracts to the adjacent parts: adhesion, indeed, is the only means by which a wound of this description can be healed.

M. Petit remarks, that among the numerous facts which might be adduced in proof of the difficulty with which a wound of the stomach permits the aliment to be extravasated, the operation of an emetic in this case is a striking one. Petit expresses his belief, that vomiting does not depend upon the action of the muscular fibres of the stomach, but entirely upon the sudden and violent contraction of the abdominal muscles. This author conceives, that, if the particular action of the stomach itself had much concern in the production of vomiting, an extravasation of the alimentary matter would necessarily happen in the abdomen when that viscus is wounded. However, in the instances referred to by Petit, the occurrence did not take place, because, notwithstanding the violence with which the abdominal muscles and diaphragm contracted, they made equal and uniform pressure on all sides of the stomach. The danger of an extravasation is also less, inasmuch as a wound of the stomach is always much smaller in relation to its cavity, than that of a bowel, in regard to the intestinal canal.

Circumstances are very different, in respect to wounds of the gall and urinary bladders, especially when these receptacles are full. An extravasation is then an inevitable consequence, both on account of the great fluidity of the bile and urine, and of the contractile power with which the parts are endued, and against which the action of the abdominal muscles makes no sort of resistance. An extravasation of these fluids is extremely dangerous, by reason of their irritating quality with respect to the viscera. The colics,

tics and irregular contractions which such stimulating fluids excite, cause the extravasation to become more widely diffused. The ease also, with which the bile and urine mix with the serum, that naturally moistens the surfaces of all the viscera, leads us to suspect, that whenever those fluids are extravasated, they very soon become universally dispersed among all the convolutions of the intestines.

Against these latter extravasations little can be done, and unless they are in small quantity, and their increase can be prevented, the patient's life hardly admits of being saved. Leaving a catheter in the bladder, indeed, is a sure means of hindering the extravasation of urine from augmenting; but not much confidence can be placed in the kind of outlet afforded by the duct of the gall-bladder.

When the extravasated matter is completely encysted and circumscribed, it happens, that as such matter had to overcome the resistance of the parts before it could be effused, no sooner is a passage afforded for its escape, than the reaction of the separated parts necessarily forces out whatever fluid has insinuated itself between them. This is a third consequence, which is pointed out by Petit as resulting from the resistance, made by the reciprocal action of the abdominal viscera, to extravasations.

The foregoing observations tend to shew, that an extravasation in the abdomen, and especially one of blood, may be as completely discharged as a collection of fluid in the thorax. The evacuation, at least, may always be easily effected, when the extravasation is bounded at any part by the parietes of the abdomen: a circumstance, which must invariably occur, whenever the extravasation is considerable. Indeed Petit informs us, that it was always the case, as far as his experience went even when the effusion was not very copious.

It is not enough to make surgeons understand, that fluids, extravasated in the abdomen, admit of being discharged by an operation; we deem it also necessary to explain the symptoms denoting the cases in which such a proceeding is proper.

In order to understand this interesting part of the subject, Petit, and most surgical writers after him, have advised us to draw a distinction between the consecutive symptoms and the primary ones, or those which attend the wound from the first, and are, strictly speaking, proper to it, because they depend essentially upon the division of the injured parts. Such breach of continuity occasions, from the first, pain, irritation, tension, convulsions, and swelling and inflammation of the abdomen, affections naturally leading to other consecutive symptoms, which vary according to the injured parts, and the degree of inflammation. Of the latter class are, hiccough, vomiting, constipation, suppression, or retention of the bile and urine, a great deal of fever generally at first, and, after the inflammation has attained a certain pitch, a concentration and sinking of the pulse, considerable prostration of strength, and cold sweats.

If when the first train of symptoms has been relieved, and after an interval of from four to eight days or more, the symptoms recur, or become exasperated, without any apparent cause, we may infer that such consecutive complaints depend upon an extravasation.

It may at first seem extraordinary, that the symptoms of an extravasation of blood should be consecutive; for, as the effusion takes place at the moment, when the wound first happens, why do not the symptoms commence at the same time?

Petit has referred the reason to the following circumstances: blood, extravasated in the abdomen, does not give rise to any complaints, either by the pressure which it

makes, or by its quality; and whenever any symptoms are occasioned on the first occurrence of the effusion, they are those of weakness, depending on the loss of blood to the circulation. The extravasation afterwards becomes entirely circumscribed by the adhesions, which are produced by the inflammation around. An additional quantity of fluid continues to be secreted from the vessels into the encysted cavity of the effused blood, and consequently pain, inflammation, &c. are occasioned by the increasing distention, now produced.

We shall not stop to enquire into the accuracy of the latter part of the foregoing statement, as the fact, that the symptoms of an extravasation are consecutive, is a piece of information highly important to the practitioner, while the theory of the subject is a subordinate consideration.

The remainder of the remarks, respecting extravasations in the abdomen, and their treatment, will be found in the article WOUNDS. Some observations will also be offered, when we speak of HERNIA.

EXTRAVASATION is a term sometimes likewise used by the gardeners in speaking of gums, juices, &c. which issue out of their trees either spontaneously, or at incisions.

EXTREAM, or EXTREME, is applied to the last and outermost part of any thing; or that which finishes and terminates it on that side.

The extreams of a line are points. There is no passing out of one extream into the other, without going through the middle. Extream remedies must only be had recourse to in extream necessity.

Some anatomists apply the denomination extremes, or extremities, to the arms and legs. See EXTREMITIES.

EXTREAMS, in *Logic*, denote the two extream terms of the conclusion of a syllogism, viz. the predicate and subject.

They are called extreams, from their relation to another term, which is a medium or mean between them.

The predicate, as being likewise had in the first proposition, is called the *major extremum*, greater extream; and the subject, as being put in the second, or minor proposition, is called the *minus extremum*, lesser extream.

Thus, in the syllogism, man is an animal: Peter is a man, therefore Peter is an animal; the word animal is the greater extream, Peter the less extream, and the man the medium. See SYLLOGISM.

EXTREAM and Mean Proportion, in *Geometry*, is when a line is so divided, that the whole line is to the greater segment, as that segment is to the other.

Or, as Euclid expresseth it, when the line is so divided, that the rectangle under the whole line, and the lesser segment, is equal to the square of the greater segment.

The invention of this division is thus: let the given line be  $AB = a$  (*Plate VII. Geometry. fig. 87.*) and for the greater segment put  $x$ , the lesser will be  $a - x$ . Then, by the hypothesis,  $a : x :: x : a - x$ . Therefore,  $a a - a x = x x$ , consequently  $a a = a x + x x$ . And, by adding  $\frac{1}{2} a a$  on each side, to make  $x x + a x + \frac{1}{2} a a$ , a complete square, the equation will stand thus,  $\frac{3}{2} a a = x x + a x + \frac{1}{2} a a$ .

Now, since the latter is exactly a square, its root  $x + \frac{1}{2} a = \sqrt{\frac{3}{2} a a}$ , and by transposition it will be  $\sqrt{\frac{3}{2} a a} - \frac{1}{2} a = x$ ; which last equation is a canon for finding  $x$ .

For at the foot of  $AB = a$ , set at right angles  $CB = \frac{1}{2} a$ ; then draw  $CA$ , the square of which is equal  $AB q + CB q = \frac{3}{2} a a$ . And therefore  $AC = \sqrt{\frac{3}{2} a a}$ ; make  $CD = CA$ . From whence  $CB = \frac{1}{2} a$  being taken as the case

use requires, there remains  $BD = x$ ; which transferred into  $AB$ , shall give the point  $E$ , where  $AB$  is cut according to extremum and mean proportion.

This cannot be exactly done in numbers; but if you would have it tolerably near, add together the square of any number, and the square of its half, and extract, as near as you can, the square root of the sum; from whence taking half, the remainder is the greater part.

EXTREMS, in right-angled spherical trigonometry. When one of the five circular parts of a right-angled spherical triangle, *viz.* the three sides and two oblique angles, (for the right-angle is neglected) is pitched upon for the middle term, then the two circular parts lying immediately next to it are called extremes conjunct; and the two parts remote from the assumed middle part, or not immediately next it, extremes disjunct. See CIRCULAR PARTS, TRIANGLE, and TRIGONOMETRY.

EXTREMUM UNCTION, one of the sacraments of the Romish church, the fifth in order, administered to people dangerously sick, by anointing them with holy oils, and pronouncing several prayers over them.

It is called extremum unctio, as being only given to persons in extremity. In the thirteenth century, it was called the "unction of the sick," and not extremum unctio: for, in the earlier ages, it was given before the viaticum; which practice, according to F. Mabillon, was not changed till the thirteenth century.

The reasons he assigns for the change are, that in that age there arose divers mistaken opinions, several of which we find mentioned and condemned in the English councils; among the rest, it was held, that such as had received this sacrament, in case they recovered, might not make use of their wives, nor eat meat, nor go barefooted; whence they chose to forbear it till the last extremity, which practice prevailed. See the Councils of Worcester and Exeter, in the year 1287; that of Winchester, in 1308; and F. Mabillon, Acta Sancti. Benedicti. Sæc. iii. p. 1.

The form of extremum unctio is now deprecativæ, as the divines call it; formerly it was absolute and indicative. This sacrament is not only in use in the Latin, but also in the Greek church, and throughout the East, though under another name, and with some difference in the circumstances; in that the orientals do not wait till their sick are come to extremity, in order to anoint them; but the sick generally go to church themselves; and it is administered to them as often as they are indisposed: the Greeks taking that direction of St. James, chap. v. ver. 14. which is the foundation of the practice, in a general sense: "Is any sick among you? let him call for the elders of the church, and let them pray over him, anointing him with oil." F. Dandini distinguishes two kinds of unctio among the Maronites: the one called unctio with the oil of the lamp; but this, he suggests, is not the sacramental unctio ordinarily administered to such as are in extreme sickness; because the oil is only consecrated by a priest, and it is given to all who are present; not to the sick only, but also to the healthy; even the priest who officiates partakes of it. The other kind of unctio, according to that father, is only for the sick; this is performed with oil consecrated by the bishop alone, on Holy Thursday; and this, it seems, is the sacramental unctio.

The unctio with lamp-oil is in use, not only among the Maronites, but throughout all the Eastern church, who use it very religiously. The truth is, they do not seem to have any other sacrament of extremum unctio beside this. Yet F. Goar observes, though it be only a ceremony,

with regard to those in health, it is a real sacrament to those that are sick.

In their great churches they have a lamp, wherein this oil for the sick is preserved; this lamp they call *καυθήλα τε ψευδαίων*, that is, *the lamp of oil joined with prayer*; for what the Latins call extremum unctio, the Greeks call *ευχλαίων*, or *αγιον ελαίου*, that is, *oil with prayer, or holy oil*.

EXTREME, in Music, is applied to such intervals as deviate as much as possible from the true chord of the same name, without changing their names; generally when the term extreme is added to the prefix diminished or superfluous (which denote a minor semitone), its effect is to double that diminishing or superfluous effect, or to make it  $\frac{57}{32} \circ = 72 \Sigma + 2f + 6m$ ; but sometimes we find Mr. Orwend applying a major comma and a minor semitone as the effect of his term extreme, or  $\frac{123}{32} \circ = 47 \Sigma + f + 4m$ , = the medius semitone: at other times we find extreme, when added to other prefixes, to have different effects, as extreme sharp intervals, for instance, are sometimes found a minor semitone above the intervals respectively, or  $\frac{34}{32} = 36 \Sigma + f + 3m$ : but in other instances the same prefix signifies a major comma more, or  $\frac{123}{32} \circ = 47 \Sigma + f + 4m$  = the medius semitone. It were much to be wished that these various applications of terms, so perplexing to a reader, could be got rid of, and a consistent nomenclature in harmonies adopted.

EXTREMITIES, in Anatomy, is a term applied to the limbs, as distinguishing them from the other divisions of the animal body, the head, and trunk. They are immediately connected with the latter by one end, and totally free in all other parts. The numerous varieties of their form depend partly on the bones, which enter into their composition; but, in a material degree also, on the soft parts which surround these, and which give to the limbs that roundness and elegance of figure, in which beauty is united with activity and strength. The extremities, being essentially concerned in all the functions of animal life, and constituting the great agents of locomotion, are composed of organs especially destined for these purposes. Their volume is formed by bones and muscles, supplied by numerous vessels, and communicating with the common centre of sensation, the brain, by nerves distributed most extensively; producing, in one part, the most important sense of touch, and giving the spring in all to rapid and varied motions.

The extremities are four in number, divided in man into upper and lower; in other animals into anterior and posterior. Each extremity is divided into four parts; the upper into the shoulder, the arm, the fore-arm, and the hand; the lower into the hip, the thigh, the leg, and the foot. In treating of these, both separately and generally, we shall consider only the bones, and the connections between them. On these depend all the motions of the limbs, the direction and extent of action of the muscles being wholly dependent on the bony points to which they are attached, and on the form and mode of junction of the bones on which they exert their power. The influence of any muscle will be considered in the detailed description of each, and may be easily applied to the subject immediately before us.

Our present plan is to offer, first, some general observations on the external figure of the bones of the extremities, as far as it relates to their uses; on their modes of articulation and their motions. We shall next examine separately and in detail each division of the bones of the upper extremity, the ligaments connecting them, the mechanism of their articulations, and their individual motions; afterwards the combined movements of the several parts, and the powers of the member, as resulting from this construction, both in the

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passive and active state. A similar mode will be pursued in considering the lower extremity. We shall conclude with a comparison between the upper and lower limbs as to size, figure, direction, motions, and growth.

The bones determine essentially the size, figure, and direction of the extremities, forming, by their assemblage, solid and flexible columns, capable of motion in very varied directions. Some of these in each column differ very widely in form; while others partake of the figure of both opposite varieties. We describe them under the different names of long, of broad or flat, and of short bones.

In the limbs the bones diminish successively in length and size, and increase in number, as we descend from the trunk to the opposite extremity, from the arm, or thigh, to the fingers or toes. In consequence of this arrangement the upper part of the limb enjoys extensive motions, whilst the lower is characterized by multiplied, but confined movements. These bones have every where an analogous structure, being broad and voluminous at their *extremities*, contracted, and frequently rounded in their middle part, or *body*. The increased volume of the extremities possesses the double advantage of enlarging the articular surface, and thereby diminishing the chances of displacement, and of preserving the symmetry of the limb. We perceive, for instance, that the bellies of the muscles correspond to the middle or smallest part of the bone, while the flat and contracted tendons are fixed near the protuberant extremities. The augmentation of size, in the ends of the long bones, is by no means sudden; it commences insensibly from the body. We remark, on these extremities, various eminences, subservient to the purposes of articulation, or giving an advantageous attachment to tendons. The middle part, or body, is generally smooth, offering prominent lines for muscular or tendinous attachments. These, where strongly marked, destroy the cylindrical form of the bone: they are usually three in number, longitudinal, separated by plane surfaces, and give the bone a prismatic figure, as may be observed in the arm, fore-arm, and leg. In these instances a section of the bone is manifestly triangular; yet its internal canal preserves a circular form. We may observe also, that the body, in nearly all the long bones, appears as if twisted on itself; so that the direction of the upper end differs more or less from that of the lower. This is rendered evident, by tracing the oblique course of the prominent lines between the two extremities; for example, in the bone of the arm.

The long bones are formed from three points of ossification. The first of these is observed in the centre of the body, extending on each side to the extremities, at which the bony cylinder is arrived at the period of birth. Soon after this time, a point of bone is perceived in the centre of each cartilaginous extremity, which increases gradually, advancing towards the body, with which it at last unites. From this consideration of the figure and formation of the long bones, we may naturally derive the arbitrary division into a *body* and two *extremities*; which division we shall adopt throughout. The body of the bone is the *diaphysis* of some Latin writers; and the two ends being at first united to the body only by cartilage, are called *epiphyses*.

The broad bones are not found so generally in the extremities as those of the long form; we observe them only at the part immediately united with the trunk, where they offer an ample space for the attachment of the powerful muscles concerned in moving the limb. In our description we observe two *surfaces* and a *circumference*. The former, if they give attachment to muscles, are usually unequal and rough; the latter is thicker than the middle of the bone,

offering more points of origin to muscular fibres, as we may observe in the margin of the hip bone.

The short bones of the extremities are found in situations where it was requisite to unite a certain degree of mobility with firmness, as, for instance, in the foot. They are collected in considerable number in the regions which they occupy; and have numerous eminences and depressions on their external surfaces, necessary for their reciprocal articulations and for the insertion of the connecting ligaments. Nothing can be more irregular than their figure, which, in addition to their comparative smallness and number, has given rise to much ambiguity of description. By considering them under the same aspects as the other bones, and by carefully noticing their relations to these, all confusion may be avoided. The short bones, in general, continue longer in a cartilaginous state than the others, resembling, in the phenomena of their ossification, the epiphyses, or extremities of the long bones.

There still remain some small bones, found only in the extremities, which can hardly be included in either of the above classes, and are distinguished by the epithet of *sesamoid*. They possess this peculiarity, that they are formed, not in common cartilage, but in the middle of a tendon, or ligament, and that no trace of them can be observed in early life. Of their use we shall speak hereafter.

There are some general characters belonging to all the above-mentioned classes of bones. We observe in all eminences and hollows, either giving attachment to muscles, or ligaments, or forming surfaces for articulation. The eminences designed for the former purpose are very numerous in the bones of the extremities, and vary greatly in figure. They sometimes appear only as asperities impressed in the midst of a smooth surface, giving origin to a number of distinct aponeurotic fibres; sometimes as prominences or tubercles more or less elevated and rough, giving insertion to one or more tendons; or, lastly, as a continued raised line. In general these eminences are proportioned to the muscles which are fixed to them; so that under which-ever form they appear, there is an equality of space allowed for the tendinous insertions of muscles of equal bulk. They are in general less strongly marked in the female than in the male; in the infant than in the adult; in feeble animals than in the carnivorous tribes, which live by preying on others. Their prominence is indicative of vigour and activity of motion; being more developed as the muscles are more powerful. This is strikingly exemplified by a comparison of the bones of a well made and muscular man, where the outline of each muscle might be traced with energy and precision through the skin, with those of a weak and ill proportioned male, whose rounded and faintly marked limbs, resembling those of the female, betray a total want of vigour or address. The uses of these eminences may be clearly traced to their removing the insertions of muscles farther from the centre, or axis of the bone, and consequently increasing their power of moving it. The eminences, which give attachment to ligaments, possess the advantage of removing the ligament farther from the joint, and thereby facilitating, and giving greater extent to its motions. These eminences have received different names, according to their situation, their direction, or figure, as we shall see more particularly hereafter.

The hollows observed on the external surfaces of the bones, (with the exception of articular cavities, of which we shall speak below,) are designed either for the attachments of muscles, or for giving passage to their tendons. The first of these have the evident advantage of increasing the surface, without augmenting the bulk of the bone;

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the latter appear as gutters, or grooves more or less deep, lined by cartilage, and completed by very strong ligamentous bands, through which the tendons glide in their way to their final attachments.

The connections between the bones of the extremities, whatever be their mod., are known by the general term of articulations. Their varieties have given rise to numerous technical, and in some measure obsolete, names, for which we refer to the articles *JOINT* and *DIARTHROSIS*. Some joints allow of motion in every direction; and we may trace a gradual decrease of mobility, through many intermediate steps, till we arrive at articulations which admit only of a gliding of the bones on each other. We have examples of the first in the joints of the shoulder and hip; where the extent of motion requires rounded articular surfaces, concave and convex in the opposite contiguous bones; constituting what is commonly termed the ball and socket joint. In man the moveable bone has the rounded head, the supporting bone the corresponding hollow. In some animals we have instances of a contrary disposition, in which a concavity in the moveable bone moves in all directions on an opposite convex surface. This mode of connection is found only in the shoulder and hip; and one advantage resulting from this structure being found at the upper part of the limbs, is, that the whole member necessarily partakes of the same extensive motions; while it allows of a greater firmness and solidity in the inferior articulations. The joints we have just mentioned are, in this sense, the joints, not only of the bones of the arm and thigh, but of all the limb, the motions of which, considered as a whole, they essentially and principally influence. Hence, if their mobility is destroyed, either by accident or disease, the limb becomes useless: whilst a similar occurrence in the inferior joints produces a partial inconvenience only. By this arrangement also, the joint, which, from its want of firmness, is most liable to injury, is the furthest removed from the immediate action of external bodies.

The extent of motion decreases as we proceed towards the extremities of the limbs. We find no rounded head, whose axis makes an angle with that of the cylinder of the bone, but an articular surface placed directly at the top or bottom. Of this we have examples in the connection of the collar bone with the breast, of the fore-arm with the wrist, &c. In these, all power of rolling the bone, which is enjoyed in a high degree by the thigh, and by the arm, is deficient. In the next step, the motions are confined to flexion and extension, as in the elbow, the knee, and the middle of the fingers. In this division the articular surfaces consist of eminences and hollows adapted reciprocally to each other, allowing of motion in one direction only. They are remarkable also for their large extent, which imparts to them solidity; and for admitting a greater degree of motion in the direction of flexion, than in the opposite one of extension, as may be observed in the knee, elbow, and fingers. The degree of extension is always effectually limited, either by a projection of bone, as in the elbow; or by strong ligaments, as in the knee, &c. In other instances, the articulation allows of rotation only; a convex surface turning in a concave, or a hollow surface rolling over a convex one; both of which may be seen in the motions of the bones of the fore-arm. In the last kind we observe only a gliding of plane articular surfaces on each other, more or less obscure, limited on all sides by ligaments binding the bones closely together. To make up for this very confined motion, we usually find many such joints united, producing in this state a more sensible degree of motion than could possibly occur in any of them singly. This may be seen in the wrist.

In all these articulations we find a smooth and polished crust, of an elastic substance, called cartilage, on the surface of the corresponding bones, the immediate means of their motions on each other. It is supposed to obviate by its elasticity the dangers resulting from sudden and violent shocks. The two corresponding cartilages of opposite bones are so disposed as to touch at all points in some positions of the limb, whilst in others they quit each other more or less, and are found opposite the soft parts surrounding the articulation. They are moulded into the form of the bone to which they adhere, preserving its general figure. But in some cases the cartilage is thicker in its middle than at the edges, thereby increasing the convexity; in others the converse may be observed, and the hollow of the articular surface is proportionably increased. Both occur in the hip and shoulder: the first in the heads of the thigh and arm bones, the last in the cavities which receive them, and in this manner the uniformity of contact is preserved. In the other articulations the cartilaginous crusts are nearly of equal thickness throughout.

The contact of the articular surfaces is secured by ligaments destined immediately for this purpose, and by the muscles which pass from one bone to another, supporting the joint either by the muscular fibres, or their tendons. The ligaments are formed by very strong fibres, a little elastic, disposed in parallel lines, or interlaced in various directions. Their great resistance insures, at all times, more particularly when the limb is at rest, the relations between the opposite bones; their situation limits in a great degree their inordinate motions. We observe them under many forms, and named either from these, or from their situation. Among the first are capsular ligaments, which are found surrounding some of the joints like cylindrical bags, embracing the opposite bones by the circumference of the two ends. Of this we have examples in the hip and shoulder, and nowhere else perhaps in the extremities. The ligamentous fibres are here interwoven and strengthened by the adherence of the surrounding tendons, lost at either extremity in the periosteum, to which they are firmly united. The reason why capsular ligaments are found only in these articulations will be readily understood. They enjoy motion in every way nearly alike, and require on all sides an equal degree of resistance. Where, from the form of the articular surfaces, the motions are confined to narrower bounds, ligaments are necessary only in particular situations in order to regulate them. We find them in the other joints generally on the sides, from which the name of lateral ligaments. These are sometimes rounded, sometimes flat, interwoven with the periosteum at each extremity, formed of fibres lying in parallel lines, or diverging at either end. There are other ligaments, not directly concerned in the joint, which still strengthen and regulate its motions, as may be remarked particularly in the shoulder. Besides these we observe many irregular slips, or bands of ligaments, dispersed here and there over the joint separated by fat and cellular tissue from the neighbouring parts. The ligaments, of whatever description, unite the opposite surfaces of bones, prevent their displacement, and yet allow of easy and rapid motions; a double advantage arising from their firmness on one part, from their flexibility on the other. They sometimes give attachment to muscles.

The muscles surrounding the joints of the extremities are very powerful agents in securing their contact, and the more so as their power increases in proportion as the chance of displacement is greater. The most vigorous efforts at displacement are made during violent and extended motions; at such times the muscles passing from bone to bone, and

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crossing the articulation, are strongly contracted, are firm in their contractions, and powerfully oppose the tendency which the extremities of the bones may have to abandon each other. In repose, when the muscles are relaxed, and offer but little resistance, the chances of luxation are few, but if they occur, the probability of its taking place is exceedingly increased.

In some joints of the extremities we find a substance of a somewhat cartilaginous structure, occupying the interval between the cartilaginous surfaces, and called for this reason inter-articular cartilage. Such bodies are sometimes moveable, as in the knee, corresponding to the varying want of uniformity in the articular extremities, or fixed more firmly to the end of the bone, or the neighbouring ligaments. They are elastic and highly flexible, resembling cartilage in the first quality, the fibrous ligaments in the second. This peculiarity of structure has given rise to the name of articular fibro-cartilages, a term bestowed on them in recent times by the French anatomist Bichat.

These surfaces are all moistened by a fluid, called synovia, on the composition of which we shall not dwell here. It is secreted by a delicate membrane which completes the structure of the joint, by lining every part of its surface: whatever be the figure of the cartilages, or the ligaments, from both of which it is distinct, it adheres closely to them. It forms a bag without an opening spread over the whole organ, reflected from the cartilages to the ligaments or tendons; so that whatever it embraces is, in reality, without the articular cavity as it is termed, though projecting into it. To the whole it gives that smooth, polished surface so necessary for the easy and rapid movements the articulations enjoy, at the same time secreting the fluid which facilitates them; it gives to the joint also its peculiar shining character.

The most simple motion of articular surfaces, common to them all, is gliding on each other in opposite directions; it is often so obscure as to be scarcely perceptible. As we ascend we find it multiplied in a variety of ways. The limb can be considerably bent, or extended; it can be removed from, or brought nearer to the axis of the trunk: the first of these motions is called abduction, the latter adduction; in some cases, as in the shoulder, they are termed elevation, or depression. The motions of some joints are confined to any two of these, as in the knee; others enjoy the whole, and all the intermediate degrees, as in the thigh. The union of these different movements, as exhibited in the arm or thigh, has been called circumduction. In this case the bone, instead of being moved in one direction, and back again to the opposite, is carried successively through all, describing by its extremity a circle, or the base of a cone, the apex of which is in the articulation above. Rotation, or rolling, is very different from this. In circumduction the bone is moved from its prior situation to a more distant one; in rotation it remains in the same place, it turns only on its axis, as may be observed in simply rolling the arm.

From this cursory review of the external characters of the bones of the extremities, of their modes of connection and motions, we proceed to the detailed description of each. It will be necessary to premise, that in our terms of position and aspect, we shall always suppose the body erect, the arms depending, and the hands supine, so that the little finger is in contact, or at least next to the external side of the thigh. In this situation we shall suppose a vertical plane dividing the body into two halves, from before backward. With a clear impression of this idea we shall find no difficulty or confusion in the terms anterior and posterior, superior and inferior, external and internal, as applied to the different aspects or surfaces of bones; by the latter, internal,

we always mean the surface next the imaginary middle plane above-mentioned. These arbitrary terms, though applicable only to one determined position of the body, are yet necessary to give tolerable precision to anatomical description: when by their assistance we have made ourselves familiar with the objects they are designed to illustrate, they may be dismissed as easily as they have been adopted; our ideas of the relative situation of parts will be distinct, and may be applied readily to every possible variety of posture. In order to obviate all ambiguity, we shall introduce also the nomenclature of Chaussier, as conveying exact and precise notions of the relations of opposite bones to each other. The terms are generally simple, and always perspicuous as applied to the present subject.

*The upper extremity*—is divided into four parts; the shoulder, the arm, the fore-arm, and the hand, each of which will be separately considered.

The shoulder is the division of the upper extremity attached immediately to the superior and lateral parts of the trunk; it is formed by two bones, one broad, placed vertically behind, called the *scapula*, or shoulder blade, the other long, situated horizontally before, called the *claviclé*, or collar bone. The disposition of these bones gives the broad form and character to the upper part of the chest, which is in itself very considerably contracted at this part, its apparent breadth and magnitude being derived from the lateral apposition of the shoulders. Generally, also, there is a proportion between these and the dimensions of the chest: they are large, and strongly developed, when the latter is well formed; contracted and narrow when it is small or badly shaped. The height of the shoulder depends on the situation of the scapula; it is lower proportionably in the female, and in males of a feeble body, than in individuals of the opposite character. In the latter case, though the bones form the outline, it is the brawny muscles which fill it up, constituting, by their well-defined and massy forms, the distinguishing character of the sex in man, and other animals.

The *scapula*, shoulder blade, or omo-plâte, is a bone of an irregularly triangular figure, seated on the upper and back part of the trunk. It is connected by muscles to the head, the vertebrae, and the ribs, by articulation to the claviclé and humerus. The scapula has such a latitude of motion as to make it difficult to assign precisely its situation on the trunk. But when the arm is at rest, it covers the space between the first and eighth ribs, with its base or posterior margin at a small distance from the vertebral column, to which it approaches nearer above than it does below. At this line the scapula lies pretty close on the ribs; forwards, we find it receding considerably from the opposite surface of the trunk, in which situation it is constantly preserved by its connection with the claviclé.

For convenience of description, we divide the scapula into two surfaces, the dorsal or exterior, and the costal or interior; into three margins or colts, the superior, the posterior, or base, and the inferior, or external costa. The rounded points at which these edges meet are usually called angles, and are named, from their several situations, the superior, the inferior, and the anterior angles of the scapula.

The dorsal surface, the dorsum, or back of the scapula, is divided into two very unequal portions by a strong and solid process of bone projecting from it transversely, called the spine of the scapula. It commences at the posterior margin, about one-fourth part of the whole length below the superior angle, increases gradually in depth as it ad-

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vances obliquely forward towards the anterior angle, beyond which it projects in the form of a broad, flat process, called the acromion. The spine is connected with the whole breadth of the dorsum, with the exception of that portion of it called the neck; its anterior edge is smooth, rounded, and concave, and is gradually lost in the under surface of the arch of the acromion. The posterior, or projecting ridge of the spine, is broad and flattened, varying however in breadth in different parts. At its commencement is a smooth, triangular space, over which passes a part of the tendon of the trapezius. Further on it is rough, the upper margin of the crista giving attachment to this muscle, the lower to the posterior half of the deltoid. The acromion is flattened in a direction contrary to that of the spine of which it is a continuation, is of considerable breadth, rough and somewhat convex above, concave and smooth below. On the internal edge, which is continuous with the superior crista of the spine, is a smooth oval surface for articulation with the clavicle. The external edge is rough and irregular, giving attachment to the middle part of the deltoid. The summit of the acromion is rounded, and marked by the attachment of a ligament which connects it with the coracoid process. Towards the anterior part of the basis of the spine, near the neck, we observe holes for the admission of the nutrient vessels. The upper surface of the spine is hollow, forming a portion of the supra-spinal fossa, the name given to that portion of the dorsum situated above the spine, and which gives lodgment to the supra-spinatus muscle. The lower surface is also concave, though irregularly so, and contributes to the formation of the infra-spinal fossa, the part of the dorsum lying below the spine, which is occupied by the infra-spinatus muscle; the latter portion scarcely deserves the name of fossa, being convex in its centre. Towards the inferior part of the dorsal surface is a ridge running in the direction of the inferior costa, for nearly its whole length; it gives attachment to an aponeurosis, which separates the infra-spinatus from the teres major, and teres minor. Towards the inferior angle this ridge is met at a very acute angle by another, originating in the inferior costa. The latter forms the line of division between the two last mentioned muscles, the upper and smaller part giving attachment to the teres minor, the lower and broader to the teres major.

The under or costal surface of the scapula is concave, marked by several converging ridges running from the base towards the anterior angle. They give attachment to the aponeurotic divisions of the sub-scapularis, its fleshy bundles lying in the intervening shallow depressions. Towards the superior and inferior angles we mark some projecting points, which give attachment to the serratus major anticus, as also more or less evidently a rising line between, designed for the same purpose.

The superior margin, or costa of the scapula, is the shortest of the three borders. It is thin towards the superior angle, becomes broader as we trace it forwards to its termination in a strong curved process, called, from its similarity to a crow's beak, the coracoid process. At the root of this process we observe a deep notch, crossed by a ligament, so as to form a circular hole; in many instances the circle is completed by bone. It gives passage to the supra-scapular nerve, and usually to a branch of the supra-scapular artery and veins. Just behind this notch the omohyoideus muscle has its origin. The coracoid process is rather flattened, convex and rough above, where it gives attachment to ligaments connecting it with the under surface of the clavicle, concave and smooth below. Its internal edge gives attachment to the pectoralis minor, its exter-

nal to a strong ligament, crossing from it to the acromion, its summit to the united heads of the biceps, and the coraco-brachialis.

The base of the scapula is the longest of the three margins, offering a waving line with an obtuse projection in it, opposite the commencement of the spine; to this, and to the margin below it, the rhomboidei are attached. From its junction with the superior costa results the superior angle, to which the levator scapulae is partly attached.

The inferior costa is much broader than the other, dividing at its anterior part into two projecting lines, with a hollow between them. Towards the inferior angle, where it joins the base, the edge is thinner, and convex, giving attachment to the teres major, and occasionally to some fibres of the latissimus dorsi. The outer of the prominent lines gives origin above to the long head of the triceps; below to the teres minor. The inner line, and intervening hollow, is occupied by the sub-scapularis. The inferior costa terminates above, at the anterior angle, towards the coracoid process, in an ovate, slightly hollowed surface, called the glenoid cavity. This surface is at right angles with the plane of the bone, its long diameter perpendicular, and its broader part below. It is covered by cartilage, the edges raised a little by a fibrous ring, which adds somewhat to its depth. At the upper end of the brim is attached the long head of the biceps. The glenoid cavity is articulated with the head of the humerus; it stands off a little from the body of the bone, supported by a short process, more contracted than the brim of the cavity, called the neck of the scapula. This narrowing is more particularly observable on the back, under the spine.

The scapula is, in its structure, compact; thin and diaphanous every where but at its edges and processes, where the bone is thick and cellular. Its ossification commences at an early period in the foetus, and advances considerably before birth. At the latter period, however, the acromion, the coracoid process, and the base, still exist in the state of cartilaginous epiphyses.

The clavicle, or collar bone, is placed nearly transversely at the superior and anterior part of the chest, between it and the top of the shoulder. In figure it somewhat resembles the italic *f*; the two thirds next the sternum being of an irregularly cylindrical, or nearly prismatic form, and gently convex anteriorly; the third next the scapula flattened horizontally, broad, and with a more considerable convexity directed backwards. It is more slender, and less curved in the female than in the male.

The extremities of the bone are distinguished from their situation by the names of the external or pectoral, and the scapular, or humeral ends of the clavicle. The first of these is triangular, presents an irregular articular surface of considerable extent for connection with the sternum; its plane is nearly at right angles to the body of the bone. The scapular extremity presents also a flat, articular surface, oblong horizontally, accommodated to the opposite one in the acromion. The upper surface is rounded towards the sternum, where the sterno-cleidomastoideus is attached, smooth in its middle portion, flat and broader next the scapula. The under side, to which these characters are equally applicable, is marked near the sternal end, by a roughened surface, for the attachment of a ligament connecting the clavicle to the first rib. Towards the middle is a considerable longitudinal hollow for the lodgment of the sub-clavius muscle. Near the scapular end the face of the bone is unequal, with a rough eminence in it for the insertion of ligaments which bind it to the coracoid process of the scapula. Towards the sternum the anterior edge is broad,

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and bends gently forwards, for about one-half of its length, where it gives origin to a portion of the pectoralis major; it then becomes thinner, slopes backwards, and terminates by suddenly turning forwards again towards its junction with the acromion. It gives attachment to the anterior half of the deltoid. The curvatures of the posterior edge are the inverse of the preceding. The bone is rounded, smooth and concave for the two-thirds next the sternum; unequal and convex towards the scapula, where the trapezius is attached.

The clavicle is in structure like the other long-bones; the medullary cavity is very confined. At the time of birth its form is already strongly marked, and its ossification nearly complete.

*The articulations of the shoulder.*—The scapula is connected with the trunk by a great number of muscles, which partly support it, and allow of all those varied motions of which it is capable. It is closely bound also to the clavicle, which latter bone is immediately articulated with the sternum. We have here only to examine the two last connections, beginning with that between the clavicle and sternum, as forming the union between the shoulder and the trunk.

The sternal end of the clavicle is covered by a cartilaginous crust of considerable thickness, presenting an irregular convex surface. At the upper part of the sternum is an articular cavity, slightly hollowed, of less extent than the opposite articular surface of the clavicle, so that the latter rises considerably above it; a circumstance particularly striking in lean persons.

The ligaments which connect these surfaces are four, an anterior and a posterior, an inter-clavicular, and a costo-clavicular ligament. To complete the joint, we find also an inter-articular cartilage, dividing it into two separate cavities, and a distinct capsular membrane lining each of these.

The anterior ligament covers the front of the joint, lying between the skin and the sterno-mastoideus without, and the capsules immediately within. It is composed of fibres, which descend obliquely from the upper and anterior edge of the clavicle, diverging as they proceed to be fixed into the upper edge of the articular cavity in the sternum. These ligamentous fibres leave several intervals between them, which are occupied by cellular tissue and vessels.

The posterior ligament is smaller and not so strong as the anterior. It separates the sterno-hyoideus and sterno-thyroideus from the capsules to which it firmly adheres. It extends from the posterior edge of the clavicle to the opposite part of the sternum. The fibres descend a little in their passage, diverging as they approach the latter bone.

The inter-clavicular ligament is placed between the two clavicles, immediately above the hollow at the upper edge of the sternum, with the integuments only in front, and the sterno-hyoidei and sterno-thyroidei behind. It is attached to the upper edge of the sternal extremity of each clavicle, the fibres crossing in a flattened form from one to the other, and longer above than below; they are often separated by intervals filled up with cellular tissue.

The costo-clavicular, or rhomboid ligament, passes obliquely upward from the cartilage of the first rib to the internal edge of the under surface of the clavicle, close to its sternal end. It is flat and short, the fibres becoming longer as they recede from the sternum. In front of it lies the subclavian muscle, and immediately behind it the subclavian vein. It has no immediate connection with the articulation, but serves to strengthen it and regulate its motions.

Between the clavicle and sternum we find an intermediate round, flattened piece of fibro-cartilage, its surfaces accom-

modated to the ends of these two bones. Its circumference lying immediately under the ligaments of the joint, is united to the surface of the anterior and posterior. It is united also above and below, by means of a strong and thick fibrous substance, to the circumference of the articular surface of both the clavicle and sternum. The fibro-cartilage is thicker above, and much thinner next the cartilage of the rib. The fibres which compose it are less apparent in its middle than nearer its edges. From its close connection with the surrounding parts, it cannot be moved in any of the actions of this joint.

The capsular membranes adhere to the ligaments which surround the articulation, between the fibres of which they are often apparent. They both adhere also to the fibro-cartilage, one of them lining the cavity between it and the sternum, the other the corresponding cavity between it and the end of the clavicle. The membrane is every where delicate, its inner surface moistened by synovia, which is secreted but in a very small quantity.

From the disposition of the ligaments belonging to this articulation, there remain but few intervals not covered and supported by them; so that it nearly approaches in structure those joints which we find surrounded by a fibrous capsule, as in the cases of the shoulder and the hip, which it somewhat resembles, also in the extent of its motions.

*Articulation of the clavicle with the scapula.*—At the scapular extremity of the clavicle we find a small oval facet, covered by cartilage, corresponding to a similar one in the internal edge of the acromion. We often meet also with a delicate inter-articular cartilage, its superficies sometimes equalling the articular surfaces of the bones, at others less; it is thickest above, and adheres by its circumference to the ligaments. To secure this joint, we find ligaments above and below it; and the clavicle is further bound to the coracoid process of the scapula by strong ligaments, without being any where in contact with it.

The upper ligament forms a broad and flat band, which covers the whole length of the articulation, crossing from the upper edge of one articular surface to the other, the fibres being longer as they are seated more superficially. It lies immediately under the tendinous aponeuroses of the trapezius and deltoid, which form a strong, distinct layer of fibres, not easily separable from the ligament.

Underneath the joint lies another ligament, the fibres following the direction of the preceding, which it approaches in front, being separated behind by an interval filled with cellular tissue. Above, it is in contact with the capsular membrane; below, with the supra-spinatus. The synovial membrane is found lining the articular surfaces, reflected from one to the other, and containing but little synovia. It is sometimes double, where the inter-articular cartilage is perfect.

The ligaments which further connect the clavicle with the scapula are attached to the coracoid process, from which they pursue different directions to be inserted into the clavicle. The most delicate of these has been called the ligamentum bicornis. It arises from the inner edge of the coracoid process, near its point, and, as it advances upwards and inwards, splits into two layers, which envelope the subclavian muscle. The upper band is attached to the clavicle, near the end of the rhomboid ligament; the under layer passes to the rib immediately below it. It is not strong enough to add much to the security of the connection between the bones. The other ligamentous bands, placed between the coracoid process and the clavicle, have been divided by many authors into two distinct ligaments: one, the posterior bundle, has been called, from its figure, conoides; the other,

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for a similar reason, *trapezoides*. Though scarcely distinct in their origin, they differ so much in figure, and in the direction of their fibres, that we shall consider them as separate ligaments. The posterior ligamentum scapulæ commune conoides is attached below, by the summit of the cone, to the root of the coracoid process; above, to the rough tubercle situated on the under side of the humeral end of the clavicle. It is composed of short thick fibres, radiating as they ascend, parallel to, and continuous with those of the anterior ligament, as they approach nearer the acromion. Below, its fibres are often united with those forming the ligament crossing the notch of the scapula. The anterior ligament, ligamentum commune trapezoides, crosses obliquely from the coracoid process to the clavicle, as a broad flattened band, exceeding the preceding in length. It is fixed below to the posterior part of the upper surface of the coracoid process, above, to an oblique line proceeding from the tubercle towards the end of the clavicle. The anterior fibres are longer than the posterior; the latter, at the union with the fibres of the posterior ligament, form an angle pointing towards the acromion, and leaving in front an angular cavity which is filled by fat. These ligaments are covered by the subclavius in front, by the trapezius behind, leaving an interval of an inch or more towards the scapulo-clavicular articulation.

The scapula has two other ligaments proper to itself, which we shall describe here, although they have no immediate relation with the articulation of the clavicle and scapula. One closes the notch in the last-named bone, the other is extended between the coracoid process and the scapula. The first, consisting of a flat, compact band of silvery shining fibres, crosses from the posterior angle of the notch to the base of the coracoid process, converting it into an hole, through which the supra scapular nerve, and frequently also the supra scapular vessels pass.

The ligament placed between the coracoid process and the acromion is of a triangular form, of considerable surface, thin, and flattened. Its base is attached along the external edge of the coracoid process, from which it proceeds in two distinct bands, separated by cellular tissue, and converging, as they approach the acromion, into one common sheet. The posterior fibres pass obliquely outwards, the anterior are directly transverse; the interval between them is crossed by some scattered slips of ligament. Its upper surface is covered by the deltoid and clavicle, its lower side is in contact with the supra-spinatus. Its anterior edge is not defined, but continuous with a thick and dense layer of cellular membrane, lying between the deltoid and the tendons of the infra and supra-spinatus. This ligament completes the arch formed by the coracoid process and acromion over the shoulder-joint.

*The mechanism and motions of the shoulder.*—The scapula, by its muscular connection with the trunk, is capable of powerful and varied motion; the clavicle, on the contrary, can only follow the impulse communicated by the scapula, whose motions it regulates and limits under certain circumstances. The scapula forms the essential part of the shoulder, the clavicle can be considered only as accessory in man, and some animals who use their anterior extremities for other purposes besides progression. The scapula may in some measure be considered as defending that part of the thorax over which it moves; but its more evident use is to serve as the base of all the motions of the arm, which at the same time it increases most extensively. In this respect it differs from the hip, which is in itself motionless, although affording a point from which the thigh directs all its movements. We shall recur to this difference hereafter: in this place it will be sufficient to notice, that notwithstanding the appa-

rent want of firmness in the shoulder, it is enabled, by means of its numerous and powerful muscles, to offer a solid resistance to the impulse communicated from the arm in any of the violent actions of the upper extremity. The scapula plainly accompanies the motions of the arm, forwards and backwards, but in the simple elevation outwards, and in depression of that bone, its movement is scarcely observable. In the former cases it rotates on an imaginary axis, perpendicular to its plane, placed somewhat about the middle of the bone.

In the instance where the arm passes forward from the state of adduction, the superior angle of the scapula is lowered a little, and approaches the vertebral column, whilst the inferior recedes from it, and is at the same time somewhat elevated. Where the arm is carried backwards the converse of this occurs. In these rolling motions the clavicle is concerned but little if at all; the scapula turning on it at the joint which unites them, the articular surfaces gliding on each other, and the ligaments above and below becoming alternately stretched or relaxed, as the motions are successively continued. They, however, are not capable of resisting alone any violent effort tending to displace the bones in this rotatory motion; it is the strong ligaments crossing from the coracoid process to the tubercle of the clavicle which, by their alternate tension, secure their relations under these circumstances. This articulation is further defended from injury by the mobility of both bones, which would recede before any violent shock.

The clavicle acts as a prop, preventing the shoulder and arm from falling forwards and approaching the breast, either by their weight or by the action of the muscles which move them. It is partly preserved in its situation by muscles which are fixed to it above. Its existence is necessary for many of the motions of the upper extremity, particularly those in which it is carried forward; it favours also the circumduction of the arm, by keeping it at a distance from the trunk, and allows the whole limb to describe arcs of a sphere, the centre of which is found at its sternal end. We find consequently that animals without clavicles enjoy these motions but imperfectly, in many instances in no degree. Their abolition in the case of fractured clavicle is another proof of the utility of the latter in directing the actions of the shoulder.

The combined motions of the scapula and clavicle are those of depression, elevation, those in which the shoulder is carried forward, or backward, and the combination of these or circumduction.

When we raise the shoulder, the scapula passes during its elevation a little obliquely forward. The inferior angle advances, whilst the upper edge or costa recedes from the trunk. The scapular end of the clavicle is necessarily also raised, so as to increase the space between it and the first rib, and to diminish somewhat the angle it forms with the acromion, its sternal end pressing more and more on the articular cavity in the sternum; the rhomboid ligament is stretched, limiting the elevation, and the inter-clavicular ligament relaxed.

In depressing the shoulder the exact inverse of these effects is produced, and requires not therefore a minute detail. We shall observe only that the lower surface of the clavicle may be brought so near to the first rib, as to compress the intervening vessels very considerably, and produce a painful swelling of the arm. The depression is much limited by this contiguity of the rib, which lies pretty close to the clavicle in the most common and easy position of the shoulder.

When the scapula advances forwards its anterior angle recedes from the trunk, being kept off by the clavicle, the base at the same time approaching nearer the breast. The clavicle becomes more distant from the first rib in the horizontal:

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horizontal direction, the inter-clavicular, and the posterior ligaments are rendered tense, the sternal end pressing inwards and backwards. In this situation luxations have occurred, but the accident is rare, as the shoulder is seldom exposed to any violence under these circumstances, that by its direction would probably effect it.

In carrying the shoulder backward, the anterior angle of the scapula is brought nearer to the chest, and the base approaches the spine. As the scapula has a considerable extent of motion in this direction, and is accompanied by the scapular end of the clavicle, it will readily be conceived, that if the movement is sudden and violent, the sternal end will distend its anterior ligament, may rupture it and become luxated forwards on the sternum. In fact this is the most common mode of displacement.

The shoulder may be moved in any of the intermediate directions to those we have described; and in all we are to consider it as a lever composed of two parts, one horizontal, the other vertical, the sternal end of the clavicle being the resting point, or the centre of the movements of the lever. The continued succession of all these motions produces the circumduction of the shoulder, a motion in which the clavicle describes a cone, the summit of which will be at its sternal, and the base traced by its scapular extremity. We are not to confound this motion of the shoulder with that of rotation, described above.

The direction of the shoulder is subject to variations from the slightest motion; in general it is so inclined that the glenoid cavity points outwards, proving most evidently, if any argument were wanting, that the upper extremities are not designed to support the body in the attitude of a quadruped. In fact, in that position, the head of the arm bone would press, not against the glenoid cavity, but on the capsular ligament which surrounds it, and which is utterly incapable of long resisting the effort.

*The Arm.*—The humerus, the only bone in the arm, the largest and strongest of those of the upper extremity, is placed between the shoulder and the fore-arm. It is nearly straight, bending gently forwards below, “*tanquam ad meliorem amplexum*,” says Albinus. Of an irregular prismatic form, somewhat rounded at its upper and middle portions, flattened and gradually widening below, so as to be broadest at its lower end where it supports the fore-arm. It has the appearance of having been twisted in the middle, as if at an early period the upper end had been carried round forcibly outwards, and the lower end in the opposite direction. We divide it into two extremities, a superior or scapular, and an inferior, or cubital; and into a middle portion or body.

At the upper end, the most bulky part of the bone, are three eminences; the head, and the great and small tubercle of the humerus. The head of the humerus is rounded, forming nearly the half of a sphere, smooth, covered by cartilage, articulated with the glenoid cavity of the scapula. It stands on a very short process, somewhat more contracted than the articular circumference, called improperly, perhaps, the neck of the humerus. The head and neck are directed obliquely upwards, so that a line drawn in their axes would form an obtuse angle with the body of the bone; they are also inclined backwards with respect to the plane of the condyles at the lower extremity. From this oblique position of the head with regard to the body of the humerus, the neck is longer, and the contraction more strongly marked below than it is above, where we remark only a shallow groove dividing the head from the tubercles.

The great tubercle is placed externally, opposite to the head. It is rough, broad, and flattened; marked by three

distinct surfaces for the attachment of tendons. One, anterior, for the tendon of the supra-spinatus muscle; a middle spot, for that of the infra-spinatus, and one below for the teres minor. The lesser tubercle, placed in front of the bone, is rough, much smaller but more elevated than the last. It gives attachment to the sub-scapularis. Dividing the tubercles is a deep longitudinal groove, of which we shall speak below.

The body of the humerus, though of a very irregular form, is sufficiently marked for us to divide it into three differently inclined surfaces, and as many projecting lines between them. Owing to the twisted figure of the bone these angular lines pursue rather a spiral than a straight course.

The anterior ridge or spine commences at the inner edge of the great tubercle, and is continued through the middle of the bone to the lower end. It is rough in its upper half, giving attachment above to the pectoralis major, and lower down to a portion of the deltoid: below it is rounded and smooth, giving attachment to and covered by the brachialis internus. The internal line descending from the small tubercle, gives attachment above to the latissimus dorsi, and lower down to the coraco-brachialis and triceps. Towards the anti-brachial extremity it becomes much more prominent, affording attachment to a strong inter-muscular aponeurosis. The external edge begins at the under side of the neck, running obliquely forwards as it descends. It is but faintly marked above where it gives attachment to a portion of the triceps; is interrupted towards the middle, leaving a smooth flat surface, over which the radial nerve and accompanying vessels turn; below it rises again into a more acute, and elevated ridge, which gives attachment to an inter-muscular ligament, and some muscles belonging to the fore-arm. In the internal surface, bounded by the anterior and inner lines, we observe above the bicipital groove, continued between the tubercles and the spines, proceeding from them for some way down the bone, increasing in breadth, and gradually becoming obliterated. It is lined by cartilage, and provided with a synovial membrane, where it lodges the tendon of the long head of the biceps. Towards the lower end of the groove, at its outer side, is a rough line for the insertion of the tendon of the teres major. About the middle of the internal surface the coraco-brachialis has an attachment, and below this the brachialis internus. The external face is larger than the preceding: covered above by the deltoid, strongly marked by a rough prominence intersecting it obliquely for the insertion of this muscle. Immediately below this ridge is a broad shallow oblique depression, along which the radial nerve and some vessels pass. Towards the lower extremity the bone is slightly concave, and gives attachment to the brachialis internus. The posterior surface is smooth and rounded, altering its direction in a considerable degree as we trace it downwards: it gives origin to and is covered by the triceps.

The lower, or anti-brachial extremity of the humerus, is broad and flattened transversely, and advances a little forwards from the axis of the body of bone. In the middle is an articular surface for connection with the fore-arm, and on either side a projecting point, called tuberosity, or condyle. Of these the internal (posterior of Albinus) is the most projecting. It is somewhat flattened, continuous above with the internal spine, marked irregularly below by the attachments of muscles, and the internal lateral ligament of the elbow joint. The external condyle (prior Albinus) is much less prominent, and gives attachment to the external lateral ligament, as well as to several muscles which lie on the radial and dorsal sides of the fore-arm.

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The articular surface, placed between these two points, descends a little way beyond them. It is marked by several eminences and hollows. Next to the external condyle is a rounded eminence (capitulum of Albinus) adapted to the hollow in the head of the radius, and at its inner side is a groove for the internal projecting edge of that hollow. The remaining division forms the pulley or trochlea (rotula of Albinus) for articulation with the ulna. We observe two prominent edges and a depression between them. The edge next the radius is not so prominent in front as behind, neither does it rise so high as the edge next the internal condyle, which descends a considerable way below the rest of the articular surface, sloping gradually into the hollow of the pulley on one side, and terminating abruptly by an acute margin on the other. The hollowed part, forming nearly three-fourths of a circle in extent from before backwards, is much broader behind, directed from thence obliquely inwards as we follow it to the front of the bone. Above the middle of the pulley, at its back part, is a deep cavity, oblong transversely, which receives the olecranon, or extremity of the ulna, during the extension of the fore-arm. Opposite to this, at the termination of the pulley in front, is a smaller hollow for the reception of the coronoid process of the ulna, when the fore-arm is bent. Between these corresponding hollows there remains but a thin plate of bone, in many instances diaphanous.

The humerus resembles in structure the other long bones. Its ossification commences at three points; at the middle and at each end. At the time of birth the scapular extremity of the humerus is entirely cartilaginous, and of greater proportionate bulk. At the lower extremity the capitulum is much larger in comparison with the trochlea than in the adult bone.

*The articulation of the humerus with the scapula, forming the shoulder joint.*—The head of the humerus is covered by a layer of cartilage, much thicker in the middle than at the circumference. The glenoid cavity of the scapula is lined by cartilage, thinner in the middle than round its edges. The margin of the cavity is further provided with a fibrous elevated border, proceeding above from the tendon of biceps which gives off a bundle on either side; below, from the circumference of the articular cavity. Over the joint is the bridge formed by the acromion, the coracoid process, and the ligament stretched across between them. The head of the humerus moves on the glenoid cavity; but from the small relative size of the latter, the surface of the head of the humerus in contact with it forms but a small part of its articular superficies, the remainder of which is thus out of the cavity, and corresponds to the capsular ligament.

The capsular or orbicular ligament encloses the whole of the joint in the form of an oblong sac, contracting a little at each extremity. The upper edge is fixed round the glenoid cavity of the scapula, beyond the fibrous ring we have just mentioned. In some instances there is an interval left on the inner side, which is then supplied by the tendon of the sub-scapularis. The lower edge is attached round the neck of the humerus; close to the margin of the articular cartilage above, at a greater distance from it below. The attachment is interrupted between the two tubercles, the ligament crossing from one to the other over the bicipital groove. The deficiency occasionally observed on the inner side is supplied as above by the tendon of the sub-scapularis, which may be seen from within the joint covered only by the reflected synovial membrane. The capsular ligament is remarkable for its length, which allows the articular surfaces of the two bones to be separated from each other, by the distance of an inch, on the admission of air into the

cavity. It is covered above by a dense ligamentous band passing from the outer edge of the coracoid process, to the anterior part of the larger tubercle, where it unites with the tendon of the supra-spinatus; and so closely joined by its under surface to the capsular ligament, that, but for its attachment to the coracoid process, it would be difficult to make any distinction between them. It is this accessory band which makes the capsular ligament thicker above than in any other part. The shoulder joint is further strengthened by the tendons of the supra-spinatus, infra-spinatus, teres minor, and sub-scapularis, which surround it, and which are firmly united to different parts of the capsular ligament. The latter is in contact also with the deltoid above, and the origin of the long head of the triceps below. It is formed by fibres running in various directions, and crossing each other, is thinnest where covered by the infra-spinatus, and teres minor, stronger on the inner and under sides; apparently insufficient to secure the firmness of the articulation, if not supported by the muscles proceeding from the scapula. The synovial membrane is spread over its internal surface, and reflected over the articular cartilages. At the edge of the bicipital groove a process goes from it, which descends along the groove, lining it for the space of about an inch. It is then reflected on all sides over the tendon of the long head of the biceps, and continues to give it a covering in its passage through the joint to its attachment above the glenoid cavity. By the reflection of the sheath below, the escape of synovia is prevented, and the tendon may still be said to be exterior to the cavity of the joint.

*The mechanism of the shoulder joint as to mobility and resistance.*—Although motion be the principal office of the upper extremity, there are many accidental circumstances in which firmness of opposition is as necessary as in the lower, and the means nearly as complete.

The motions of the arm are very extensive, generally combined in different degrees with those of the shoulder. Indeed so great is its mobility, that it escapes on that account many injuries it would otherwise be liable to, from the looseness of its articulation with the shoulder. Add to this that the point of support, the glenoid cavity of the scapula, is in itself so moveable, as further to modify and lessen the effects of external impulses. We have before observed that the scapula more particularly accompanies the arm in its motions backwards and forwards, less so in its elevation outward and depression; the clavicle necessarily partakes of the movement, and from this disposition two advantages are derived that the circuit of motion is enlarged, whilst tendency to displacement is diminished by the distribution of the effort over three points instead of one.

The arm, and consequently the whole limb, may be elevated, depressed, carried forward, backward, and in all the intermediate directions; it may be rolled also on its axis in any of these conditions.

When the arm is raised, the head of the humerus glides from above downwards in the glenoid cavity, in some measure abandons it, and rests against the lower side of the capsular ligament, which it distends more or less according as the scapula has accompanied it in its movement. If the arm be elevated outwards or abducted, it cannot be much assisted by the scapula; the great tubercle is buried under the arch formed by the acromion, the coracoid process, and the ligament between them, and in this situation the capsule is particularly stretched, is liable to be torn, and the arm luxated downwards. When the arm is thus raised above the horizontal line, at a distance from the trunk, the weight of the body brought to bear with force on the head of the bone, as in the case of falling, tends to de-

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press it; and at the same time the actions of the pectoralis major, latissimus dorsi, and teres major, concur in producing the same effect; since they have their fixed points in the trunk, and their moveable point in the humerus. Luxation, under these circumstances, is by no means rare. The action of muscles alone is scarcely adequate to the effect, which is generally the consequence of some violent impulse.

In depression or adduction, the arm returns to its natural position, in which displacement is almost impossible. Where the limb is perpendicular, any external impulse acting on its lower end, would only press the head of the bone firmly against the arch of the acromion. The only mode in which it could be made to pass beyond the arch, would be by carrying the lower end inwards; but this is opposed by the trunk, so that in this position of the arm luxation upwards is effectually prevented.

When the arm is carried forward to a considerable height, it is accompanied in its motion by the rotation of the scapula, and the head of the bone scarcely quits the glenoid cavity. It is on these accounts that when in falling forward the arm is projected considerably beyond the head, luxation is rarely the consequence, though the shock be severe. In the motion backwards the head of the humerus quits in some degree the articular cavity, and bears against the capsular ligament and the tendon of the sub-scapularis. The extent of this motion is also increased by the coincident movement of the scapula, and at the same time the probability of luxation diminished; it is not, however, so free as the motion forwards.

Circumduction, or the succession of these motions, is enjoyed extensively in the joint of the shoulder; the execution of it in the anterior half of the circle is more easy, because more unconfined than in the posterior. And we may observe as a general axiom, applicable to all the motions of the arm, that the movements forwards are far more extensive than those in the contrary directions, whatever be the point from which they commence, in whatever direction the limb may be; examples of these are too familiar for us to particularize them, the cause will be readily understood from our account of the mechanism of this part of the upper extremity.

The rotation of the arm takes place exclusively in the shoulder joint, not accompanied as the others by any corresponding motion of the scapula and clavicle. In this motion the head of the humerus merely glides backwards or forwards in the glenoid cavity, according as it is rolled inwards or outwards; it is not extensive, and cannot give occasion to displacement of the bones. In cases where the functions of the elbow joint have been so far destroyed, as to prevent the rolling of the bones of the fore-arm one over the other, the rotation of the humerus has been observed to be more marked, to compensate the deficiency.

The fore arm, placed between the arm and the hand, is composed of two bones, the ulna and radius.

The ulna, the largest of the two, is on the inner side. Irregular in shape, strong, and larger above, lessening gradually in size to its lower end. We divide it into two extremities, an upper or humeral, a lower or carpal; and into a middle portion or body.

The humeral extremity comprises two strongly marked eminences, the olecranon and coronoid processes, and two lunated cavities, the largest articulated with the pulley in the lower end of the humerus, the lesser with the head of the radius. The olecranon projects beyond the coronoid process in a line with the body of the bone; it is strong, somewhat curved, rough above, where it affords attachment to the triceps; smooth behind, where it lies immediately

under the skin; concave before, where it forms the upper part of the great sigmoid cavity. The coronoid process stands opposite to the olecranon in front of the bone. Its upper surface forms the lower part of the last named cavity, the under is marked by the attachment of the brachialis internus. The edge next the radius is hollowed by the lesser sigmoid cavity, the opposite margin is acute, and gives attachment to the pronator teres, the flexor sublimis, and the internal lateral ligament of the elbow joint. The great sigmoid cavity (sinus lunatus of Albinus) lies between these processes. It is deeply concave longitudinally, adapted to the figure of the trochlea of the humerus; divided transversely in the middle by a contraction of the articular surface, and a faintly marked line between the narrowed points. The upper division made by the olecranon is the largest. The cavity is divided also into two unequal portions, by a convex line traversing its whole length, the internal division is the largest, and most hollowed, for the reception of the inner border of the trochlea. The lesser sigmoid cavity is oval transversely, slightly hollow, continuous above with the larger cavity.

The body of the ulna is of an irregular prismatic form, largest above, curved gently forward, and turning towards the radius below. We distinguish in it three surfaces, and a like number of angular ridges between them. The anterior edge or spine passes from the lesser sigmoid cavity in a curved line to the carpal extremity; it is acute above, and gradually softened below, till it becomes scarcely visible. It gives attachment to the interosseous ligament. The internal edge (posterior, Alb.) is rounded, giving attachment to the flexor profundus above, to the pronator quadratus below. It follows a curved line from the inside of the coronoid process, and is somewhat more prominent below, for the attachment of the latter muscle. The posterior edge (exterior, Alb.) beginning from behind the olecranon, is strongly marked in its upper two thirds, and insensibly lost below. It gives attachment to an aponeurosis. The anterior surface (latus interius, Alb.) is broader above than below, gibbous in the middle, and concave at each end; the hollow part below is occupied by the pronator quadratus, the remainder gives attachment to flexor profundus. Towards the upper end is a small hole directed upwards for the admission of the nutrient vessels. The posterior surface (prius, Alb.) is divided through its whole length by a prominent line; at the upper end of the internal division is a triangular space for the attachment of the anconæus; below it is covered by the extensor carpi ulnaris. The external division, that nearest the radius, gives attachment above to the supinator brevis, below to the extensors of the thumb and fore-finger. The internal surface is broad, and a little concave above, giving attachment to the flexor profundus, convex and much narrower below, lying immediately under the skin.

The carpal extremity is small, marked by two eminences; one placed externally, called the head or capitulum, the other, from its shape, the styloid process. The head presents a rounded articular surface, corresponding below to a triangular inter-articular cartilage placed between it and the carpus; externally to an articular cavity in the inner side of the carpal extremity of the radius. The styloid process projects beyond the head; it is small, of a conical shape, the point giving attachment to the internal lateral ligament of the wrist. Between these processes is a transverse groove, which gives attachment to the fibro-cartilage just mentioned. Behind they are separated by another longitudinal groove, which lodges the tendon of the extensor carpi ulnaris.

The ulna is formed from three points of ossification, as the

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Other long bones. At the time of birth the form of the olecranon is fully determined, whilst the coronoid process projects but little. The consequence is, that the great sigmoid cavity is less concave in comparison than in the adult, and the lesser sigmoid cavity is proportionably small and shallow.

The radius is situated on the outer side of the fore-arm. It is shorter than the ulna; smaller above than below, and gently curved in the middle. The upper or humeral extremity, called also the head of the radius, presents a circular articular surface; slightly hollowed in the middle, corresponding to the rounded eminence on the cubital end of the humerus. The smooth articular surface is continued a short way down the bone, and is broadest on the inside, where it lies in the lesser sigmoid cavity. This division is supported by a narrower portion of bone, cylindrical, and of an inch in length, called the neck of the radius. Immediately below, on the inner side, is an oval protuberance, smooth on its anterior half, over which the tendon of the biceps passes, separated from it by a bursa mucosa; rough posteriorly where this tendon is inserted.

The body of the radius is of an irregular prismatic form, which makes a natural division of it into three faces, and as many angular lines. The anterior edge is more prominent above than below. The upper part gives attachment to the long flexor of the thumb, to the flexor sublimis, and to the supinator brevis; its lower to the pronator quadratus. The internal edge or spine, acute in the middle, rounded at each end, gives attachment to the interosseous ligament. The posterior, prominent also in the middle, and disappearing insensibly above and below, gives no muscular attachments. The anterior surface is concave above, where it gives origin to the flexor longus pollicis; a little convex below, where the pronator quadratus is fixed. About its middle is the hole for the nutrient vessels of the bone. The posterior surface, like the former, increases gradually in breadth from above downwards, is irregular, gives attachment above to the supinator brevis, and lower down to the extensors of the thumb; its inferior part, covered by the extensor communis, the extensor tertii internodii pollicis, and the indicator. The external surface is convex throughout. Its upper third gives attachment to the supinator brevis; about its middle is a rough eminence, into which the pronator teres is implanted; below it is covered by the radial extensors of the carpus.

The carpal extremity is larger than the superior, irregularly quadrilateral, the longest side anterior. We observe in it an articular cavity, oblique, slightly hollowed, crossed by a rising line from before backwards, adapted to two of the bones of the carpus; the outer division to the os scaphoides, the internal to the semi-lunare. The anterior edge of the cavity is rough for the insertion of ligaments. The posterior offers two grooves; the internal, broad and superficial, gives passage to the extensor communis and indicator, the outer, narrow and deeper, follows an oblique course from within outwards and downwards: through it passes the extensor tertii internodii pollicis. On the inner margin is a lunated articular surface, corresponding to the capitulum of the ulna. The outer side, divided from the posterior by a rising spine, is marked in a similar manner by two hollows. The anterior offers two grooves for the extensores primi and secundi internodii pollicis; the posterior is marked by the tendons of the radial extensors. At the sharp ridge, between this side and the anterior, the supinator longus is implanted. The prominence between the hollows is continued downwards into a blunt process, passing beyond the articular surface, called the styloid process of the radius. It gives

attachment to the external lateral ligament of the wrist. The radius resembles, both in its formation and structure, the other long bones. At the time of birth its extremities are yet cartilaginous; the lower end is soonest completely ossified.

*The elbow joint; the articulation of the ulna and radius with the humerus.*—The lower end of the humerus presents an articular surface composed of alternate eminences and depressions, covered by a continued crust of smooth cartilage. The great sigmoid cavity of the ulna is lined by cartilage, interrupted in the middle by a transverse contraction and groove; continued into the lesser sigmoid cavity. The head of the radius is also covered by cartilage, continued over its circular margin for a short way down its cylinder. The humeral end of the ulna corresponds to the pulley, that of the radius to the capitulum at the lower extremity of the humerus. These surfaces are bound together by ligaments, and covered by a synovial membrane reflected from one to another.

The ligaments which more particularly secure the joint are called lateral, one being placed on its outer, the other on its inner side. The internal lateral ligament is fixed above to the internal condyle of the humerus. It radiates as it descends, dividing into two portions; the anterior is fixed to the inner side of the coronoid process of the ulna, the posterior, the smallest of the two, to the olecranon. The anterior division is covered by the tendon common to the muscles proceeding from the internal condyle, and is partially united to it. Immediately under the ligament is the capsular membrane. The external lateral ligament can with difficulty be distinguished from the common tendon of the muscles attached to the external condyle. It is fixed above to this condyle, below it is united to a large portion of the circle of the annular ligament of the radius. It is not so strong, so large, nor so clearly defined as the internal lateral ligament, its fibres diverge considerably, and are in contact with the synovial membrane. In addition to these ligaments we find scattered bands of fibres traversing in different directions, both before and behind the articulation; their irregularity scarcely admits of description. Between them and the synovial membrane lie some cellular tissue and fat. This synovial membrane is reflected from the humerus close at the margin of the articular cartilage, and is continued under the ligaments to the opposite surfaces of the ulna and radius, lining the sigmoid cavities of the first, and spread over the head of the latter. It is common therefore to the articulations of the fore-arm with the arm, and of the bones of the fore-arm between themselves. This joint is strengthened also in a remarkable degree by the numerous muscles which are attached round it, and which cover it on every side.

*The motions of the fore-arm on the arm*—are confined to flexion and extension, the ulna executing the principal part, the radius necessarily following the same direction. In a state of complete flexion the coronoid process of the ulna and the prominent margin of the head of the radius are found corresponding to the opposite hollows in front of the humerus, the olecranon below the condyles, having moved a considerable distance from the internal one. At this time the lateral ligaments are relaxed; the posterior half of the trochlea of the humerus in contact with the capsular membrane, reflected from it to the olecranon, and protected by the triceps. Under these relations the joint is secure; displacement in any direction would be almost impossible, without some fracture of bone. In the intermediate states between flexion and extension the articulation has not the same appearance of security; but from the great mobility of the lower end of the humerus; from its receding easily

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before every shock when the fore-arm is in such situation, we seldom meet with a dislocation of the latter under these circumstances. In the extension of the fore-arm on the arm, the radius and ulna glide backwards over the articular surface of the humerus, until stopped by the olecranon becoming locked in the cavity adapted for its reception in the latter bone. At this time the lateral ligaments are tightened as well as the capsule in front of the joint. It is in the state of complete extension that luxations most usually occur, the humerus passing down in front of the bones of the fore-arm. This frequently happens in a violent fall on the hands. The whole weight of the body is carried forwards with considerable impetus on the arms which are stretched out to save the head from coming to the ground. In this case the fore-arm is fixed, and the humerus, following the impulse of the body, ruptures the ligaments, and is thrust forwards, the olecranon opposing itself to all displacement backwards. It would appear also, that a dislocation might occur from lifting a heavy weight with the arm fully extended; but here the effort is voluntary, and the pain felt in the bend of the elbow is a sufficient warning to desist. When the fore-arm is extended it forms an obtuse angle with the arm, and when bent it is not found in the same line with the humerus, but slants a little inwards towards the breast. Both these circumstances depend on the obliquity of the pulley at the lower end of the humerus. This direction of the fore-arm, and consequently of the hand in the state of flexion, is particularly observable in man, and necessarily requires the existence of a clavicle, without which the fore-arm, when bent, would be carried to the opposite shoulder. Thus in the different ranks of animals the existence of a clavicle, and the motion of pronation, are found generally connected with this obliquity in the flexion of the fore-arm. In the state of demi-flexion we may observe a slight lateral motion of the fore-arm on the arm, which cannot take place in the states either of complete flexion, or extension.

*The articulations of the radius with the ulna.*—These bones are in immediate contact at their humeral and carpal extremities; between these points there is a vacancy occupied by a flat interosseous ligament. Above, the head of the radius is received into the lesser sigmoid cavity of the ulna; below, it offers a shallow articular surface, which revolves on the capitulum at the carpal end of that bone. First we shall examine the articulation at the humeral ends. It is lined by the synovial membrane common to it, and to the articulation of the fore-arm with the arm, and secured by a strong flat circular band of fibres, called the annular or orbicular ligament of the radius. This ligament forms three-fourths of a circle, which is completed by the lesser sigmoid cavity, and in which the head of the radius turns. It is about three lines in breadth, fixed before and behind to the ends of the lesser sigmoid cavity, lost insensibly above over the surface of the synovial capsule, to which it is firmly united, terminating by a more defined edge below. It is composed of parallel circular fibres, into which the external lateral ligament is fixed from above, as also some oblique fibres proceeding from the olecranon, the ligamentum adcesorium posticum of Weitbrecht. The annular ligament is of a dense compact texture, frequently cartilaginous in advanced age. It lies immediately over the synovial membrane, but is no where connected in any degree with the radius. It is covered by muscles.

The space between the upper and lower articulations is filled by the intervention of ligamentous fibres, which further secure the relations between the radius and ulna. A portion of these has obtained the name of the oblique ligament, or chorda transversalis; the remainder is included

under the general term of interosseous ligament. The oblique ligament, a small and flat band of fibres, passes obliquely from the inner edge of the coronoid process below the lesser sigmoid cavity to be inserted into the radius at a point which lies just below its tubercle. In this course it accompanies the inner edge of the tendon of the biceps, its direction being opposite to the fibres of the interosseous ligament, and in a plane anterior to them. Between this ligament and the head of the radius there is left a triangular space filled by cellular tissue, in which the tubercle of that bone revolves. The interosseous ligament commences below the tubercle attached to the inner ridge or spine of the radius, from which the fibres pass obliquely downwards and inwards to be attached to the opposite spine of the ulna. It is composed of flat parallel fibres, leaving various intervals for the passage of vessels. It is covered on both its surfaces by the deep seated muscles of the fore-arm, to which it affords attachments. It is more delicate above, insensibly losing its shining appearance, and interrupted by a large vacancy, which gives passage to the posterior interosseous vessels; stronger below, where we find another opening for the passage of the anterior interosseous vessels. On the posterior surface of this ligament, and more especially at the upper end, we often find flat bands of fibres decussating it: they have been described under the name of the posterior transversal chord.

The inferior articulation between the radius and ulna, or that at the carpal ends of these bones, is provided with a synovial capsule, and a triangular fibro-cartilage interposed between the ulna and the bones of the carpus, and filling the vacancy observed between them in the skeleton.

This triangular cartilage is fixed by its base to the prominent edge which divides the articular cavity at the bottom of the radius, from that which receives the capitulum of the ulna. It is attached by its summit to the groove between the capitulum and the styloid process. Its edges are united to the synovial membranes of both articulations, the radio-carpal and the radio-cubital. Its upper and lower surfaces are concave and smooth, the superior corresponding to the lower surface of the ulna. It is occasionally incomplete at the base, allowing of the contact of the two capsular membranes just mentioned.

The capsular membrane is loose, so as not to impede the extended rotation of the radius. It is continued from the upper surface of the inter-articular cartilage over the articular surfaces of the radius and ulna. It is sometimes covered here and there by a few scattered ligamentous fibres, which are in many instances scarcely observable.

*The motions of the bones of the fore-arm, between themselves and their powers of resistance.*—We have hitherto considered the fore-arm only in its relation to the arm, in which the ulna was more essentially concerned; the movements in the present case depend chiefly, and almost exclusively, on the radius, and are necessarily communicated to the hand with which it is articulated below, the ulna concurring but little in the construction of the joint of the wrist. These bones are thus disposed inversely as to importance in the joints of the elbow and wrist: above, the ulna plays the principal part, the radius being accessory only; whereas below, the ulna is of comparatively little importance, the radius of the greatest. Their form is accommodated to the different use of each: the ulna large above and small below; the radius of little volume at its upper extremity, broad and solid at its lower, where it supports the hand. This double opposition in the form of the bones is not only accommodated to their functions, but renders the solidity of the fore-arm nearly equal throughout.

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out: The radius, however; from its more direct connection with the hand, more immediately sustains any effort impressed on the latter, as in pushing violently; or falling, and is often fractured under such circumstances. Still the result of the general mechanism will be, that the same bone, not having to support the motions of the two joints, the elbow and wrist, motions which are often simultaneous, fractures and dislocations are the less likely to occur.

The radius may be rolled on the ulna inwards and outwards. In the former case, supposing the radius to be horizontal, the palm of the hand is turned downwards, and the motion called on that account pronation; in the latter it is turned upwards, and the motion called supination. In pronation, which is the most common position, the humeral end of the radius turns on its axis in the hoop formed for it by the lesser sigmoid cavity and the annular ligament, while the carpal extremity rolls over the lower end of the ulna, tracing an arc of a circle. In this state the relative situations of the bones are changed, the radius crossing the ulna, and diminishing the space between them. If pronation be carried forcibly too far, a dislocation may take place in either articulation; more readily in the lower, on account of the greater extent of motion, and less strength of restraining ligaments; in the upper, the radius does not quit its situation, and is secured by a very strong ligament, besides the powerful support of the muscles attached round it. In supination the radius moves in the contrary direction, until it becomes parallel to the ulna, beyond which it cannot go. If it is forced beyond these limits a dislocation of one of the articulations must ensue, most probably of the lower. A great obstacle to luxations of this joint, either in pronation or supination, is found in the triangular fibro-cartilage at the lower end of the bones, which is very strong, and which must necessarily be torn.

Although at first sight one might be disposed to imagine the ulna an immoveable fulcrum, round which the radius rolls, it is certain that in pronation the carpal end of the ulna passes outwards, in supination in the contrary direction, so that it traces arcs of a circle in a contrary way to the carpal end of the radius. Of this any one will be effectually convinced by observation or experiment. But as the ulna cannot roll on the lower end of the humerus, it necessarily involves the latter bone in the execution of these motions, which it thus assists by its powers of rotation. Pronation and supination then depend not only on the rotation of the radius, but on the opposite motion of the ulna, and the rotation of the arm. The latter of these is very much more sensible if the motions take place when the fore-arm is extended on the arm, than when it is bent: in the former case, from the disposition of the bones and ligaments, any rotatory motion of the ulna is impossible, in the latter it may exist in a slight degree.

We have observed that the disposition of the bones of the fore-arm is such as to offer the best possible resistance to external efforts: nor is their position as to these motions less favourable, the head of the radius lying a little before the ulna, and the breadth of its carpal extremity removing its axis from the lower end of the ulna, so as to increase and facilitate the pronation and supination of the hand, offering at the same time a broad basis for its support.

*The hand*—forms the fourth and last division of the superior extremity; it is articulated with the lower end of the fore-arm. It varies considerably in size and form in different individuals: most commonly is comparatively smaller in females. We distinguish in it two surfaces, a dorsal and a palmar; two edges, a radial and ulnar; and also an upper or anti-brachial, and a lower or digital

end. It is composed of twenty-seven bones, which have been arranged under the different titles of carpus, metacarpus, and fingers.

*The Carpus*.—The carpus, or wrist, is oval transversely, convex on its dorsal, hollowed on its palmar surface, where it gives passage to the flexor tendons. This hollow is bounded laterally by four eminences resulting from different bones of the carpus, which give attachment to a strong ligament confining the tendons in their situation. It is convex at the edge next the fore-arm, offering a number of irregular articular surfaces at the border next the metacarpus. It is formed by two rows of small irregularly shaped bones, the upper range called anti-brachial, the lower metacarpal. Each of these ranges is composed of four bones; those in the anti-brachial row, commencing from the radial edge, are the scaphoides, lunare, cuneiforme and pisiforme; in the metacarpal row the trapezium, trapezoides, magnum and unciforme. Although varying much in figure, they have some characters in common, which allow of our describing them with tolerable precision, without rendering confused or obscure our ideas of their mutual relations. We distinguish in each bone six surfaces, or sides; an upper or anti-brachial, a lower or metacarpal, an anterior or palmar, a posterior or dorsal, an outer or radial; and an inner or ulnar.

The scaphoides, so called from a supposed resemblance to a boat, is the largest bone of the first row. It is somewhat oval in figure, the long axis being directed obliquely from above outwards and downwards. The upper surface is convex, triangular, articulated with the radius; the lower is also convex, corresponding to the opposite surfaces of the trapezium and trapezoides. The posterior narrow, and grooved by the insertion of ligaments; the anterior long and contracted, concave towards the fore-arm; convex and projecting below, forming one of the eminences before mentioned. The outer, or radial side, is rough for the attachment of the external lateral ligament of the wrist; the internal presenting a double articular surface, the upper narrow and convex, connected with the os lunare; the lower broad and concave, forming part of the articular cavity for the reception of the os magnum of the second row.

The lunare, or semi-lunare, has obtained its name from the figure of one of its articular surfaces, which resembles a crescent. It is not so elongated in form as the last bone; convex and triangular above when articulated with the radius; concave below, narrowest in its transverse diameter, articulated with the os magnum, and in a small degree with the unciforme; rough and unequal on the anterior and posterior surfaces for the attachment of ligaments, the anterior side the smallest; the outer face narrow, smooth, in the form of a crescent, with the convexity upwards in contact with the scaphoides; the inner also smooth, plane, articulated with the cuneiforme.

The os cuneiforme (triquetrum of Albinus) less in volume than the preceding, oblong and somewhat pyramidal in shape, its base next the os lunare, its apex directed obliquely inwards and downwards. The upper surface is convex, articulated with the bottom of the ulna by the intervention of the triangular fibro-cartilage before mentioned; the lower oblique, concave, articulated with the unciforme; the anterior presents on its inner side a flat circular articular facet articulated with the pisiforme, on its outer it is rough for the attachment of ligaments; the posterior and internal are also unequal and rough for similar purposes; the external or radial surface is plane and smooth, articulated with the lunare.

The os pisiforme (subrotundum of Albinus) has obtained its

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its name from its rounded figure. It is the smallest of the bones of the carpus. On its posterior surface we observe a slightly hollowed articular surface, where it rests on the last described bone, "*affidens patellæ in modum, aut sesamoidei*," (Alb.) With this exception the bone is convex on all sides, projecting beyond the plane of the other carpal bones, rough, and unequal, giving attachment above to the flexor carpi ulnaris, below to the abductor of the little finger, and before to the annular ligament of the wrist. It constitutes one of the four prominent points of the palmar side of the carpus.

The trapezium (*multangulum majus*, Alb.) is the first bone on the radial side of the second range of carpal bones, and lies somewhat anterior to them. Above it offers a concave articular surface, semi-circular, opposed to the scaphoides; below another, convex antero-posteriorly, concave transversely, articulated with the metacarpal bone of the thumb; on the front rough, with a deep groove at the upper end for the passage of the flexor carpi radialis; the outer edge of the groove giving attachment to the annular or transverse ligament, and forming one of the eminences already mentioned; on the back and outer sides rough and unequal for attachment of ligaments; on the inner side are two articular surfaces; the upper, large and concave, connected with the trapezoides; the lower, narrow and plane, for the metacarpal bone of the fore-finger.

The trapezoides (*multangulum minus*, Alb.) is very irregular in figure, placed like a wedge between the last and the following bones, the base of it being posterior, the point towards the palm. The upper surface is concave, quadrilateral, and articulated with the scaphoides; the lower divided by a convex line crossing from before backwards, adapted to the hollow of the metacarpal bone of the fore-finger; the dorsal or posterior, convex, rough and broad; the anterior possessing the former characters, but much smaller; the external, convex articulated with the trapezium; the internal or ulnar, smaller and concave, smooth anteriorly where articulated with the following bone, rough behind for ligamentous attachments.

The os magnum (*capitatum*, Alb.) is the largest of the eight; longest in its vertical axis, rounded into an articular head above, (from whence it derives its name,) of a quadrilateral form below. The upper articular surface is convex, divided by a prominent line into two portions, one for the scaphoides, the other for the lunare; the lower is divided into three facets, the external articulated with the second bone of the metacarpus, the middle the largest of the three, concave, supporting the third, the internal or posterior very small, plane, opposed to the inner edge of the fourth; the palmar and dorsal surfaces, rough and unequal for ligaments, the latter the largest of the two, the external narrow, articulated with the trapezoides; the internal of greater extent than any of the preceding, smooth above where contiguous to the unciforme, rough below, giving attachments to ligaments.

The unciforme (*os hamatum*; *cuneiforme* Alb.) completes the second row of carpal bones, being the last on the ulnar side. Above is a rounded angle opposed to the lunare; below a smooth surface, convex transversely, the outer surface supporting the fourth, the inner the fifth metacarpal bone; on the anterior side we observe, below, a curved process projecting forward, to which the annular ligament is attached, as also some muscles of the little finger; it forms the last of the four eminences referred to before; the superior part of this surface is narrow, unequal, but smooth, giving attachment to ligaments; the posterior surface is broad, triangular, and rough; the external offers an articu-

lar surface above, in contact with the os magnum, is rough below for ligamentary connections; the internal is directed obliquely, presenting a curved, oblong, articular facet, and a rough line below it; the former opposed to the cuneiforme, the latter serving for attachments to ligaments.

The bones of the carpus resemble each other in structure; composed of a cellular or spongy substance, externally covered by a thin layer of compact bone. They are developed from single points of ossification, which do not commence till after birth. At that period they are entirely cartilaginous, distinct, well marked, and not at all proportionably larger than when fully ossified, and on this account differing from the cartilaginous extremities of the long bones.

*The articulation of the fore-arm with the carpus, or joint of the wrist.*—The superior surfaces of the scaphoides, lunare, and cuneiforme, form by their union a common convex surface, oblong transversely; each bone is covered by its proper cartilage, firmly united to the next by an intervening band of a fibro-cartilaginous structure, which separates this joint from the articulations of the carpal bones between themselves. The lower extremity of the radius, and the triangular cartilage at the bottom of the ulna, form an elliptical concave surface, which receives the opposite convexity of the carpus, so that the scaphoides and lunare are opposed to the radius, and the cuneiforme to the inter-articular cartilage which separates it from the ulna. The joint is strengthened by ligaments on each side, and also before and behind, and lined by a synovial membrane.

The external lateral ligament is attached above to the styloid process of the radius; it advances forward a little as it descends, and is fixed on the outer side of the scaphoides. The fibres of which it is composed diverge below, and become continuous with the anterior ligament: we can often trace them on to the trapezium. Its form is irregular, and by no means defined, the edges being variously connected with the parts around it. The internal lateral ligament proceeds from the styloid process of the ulna, and is attached below to the inner side of the os cuneiforme. It is implanted also by some of its anterior fibres into the annular ligament, and pisiforme bone.

The anterior ligament is broad, and flat; fixed above to the anterior part of the styloid process of the radius, and the whole anterior edge of the articular cavity; from hence the fibres descend obliquely inwards, and are fixed below in an irregular line to the scaphoides, lunare, and cuneiforme; some fibres go to the pisiforme, the greatest number are attached to the lunare. The flexor tendons lie in front, the synovial membrane immediately behind it. The posterior ligament is not so broad as the preceding, and more evidently fibrous; its direction is nearly the same, being fixed above to the posterior border of the articular hollow of the radius, below the lunare, and cuneiforme; it is covered by the extensor tendons. These ligaments are in no wise connected with the ulna, so that they cannot in any situation impede the rotation of the radius on that bone. The synovial membrane is spread over the articular surfaces of the radius, and triangular cartilage above, and the three bones of the carpus below; it is reflected between them under the ligaments, appearing in the intervals between their fibres in several spots. The joint of the wrist is strengthened on every side by strong and numerous tendons, some of which are inserted in its vicinity, others closely bound to its surface by strong transverse ligaments as they pass from the forearm to the hand and fingers. The security derived from this construction must be very great, without it the joint would presently yield to the many violent impulses it has to sustain

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sustain, to which the ligaments alone would offer a very inadequate resistance.

*The motions of the carpus on the fore-arm*—are those of flexion, extension, lateral inclinations or abduction, and adduction, and circumduction. From the close connection of the carpal bones between themselves, and with the rest of the hand, these motions of the carpus may be considered at the same time as general motions of the hand. Those of pronation and supination depend on the motions of the bones of the fore-arm, and are in nowise dependant on this joint.

In flexion the articular convexity of the carpus glides from before backwards in the corresponding cavity of the fore-arm, and the posterior ligament and extensor tendons are stretched; it may be carried to nearly a right angle without violence; an effort pressing beyond this point would strain, and might certainly dislocate the bones.

In extension an opposite succession of phenomena occurs, it is the anterior part of the joint which has the effort to sustain. This motion is not confined to the bringing the carpus and hand into the same straight line with the fore-arm, but may be continued in the opposite direction to some extent, so as to make them form a considerable angle with it on the dorsal aspect. The freedom of motion enjoyed by the carpus in this sense is subservient to many of the important uses of the hand, and is not to be found in other analogous joints, where the power of flexion is greater, and that of extension limited to bringing the opposite bones into the same axis, as in the elbow, knee, &c. The lateral motions, those of abduction and adduction, are more confined, especially the last. The lateral ligaments are alternately stretched and relaxed, preventing their too great extent. Circumduction is also confined to narrow bounds, more particularly so when pronation and supination are not concerned in producing it.

*The articulations between the carpal bones*—all communicate together, being lined by a continuous synovial membrane. The bones lie in close apposition, and are bound firmly by ligaments on the palmar and dorsal surfaces, some by ligaments passing deeply between them. The three first bones of the upper row are in contact by nearly plane surfaces covered by cartilage, the scaphoides connected with the lunare, the latter with the cuneiforme. The palmar ligaments uniting them lie deep under the anterior ligament of the wrist, the fibres of each passing transversely from bone to bone. The dorsal ligaments are more distinct, the fibres longer as they are more superficial, they have the same direction as the former. The superior, or interosseous ligaments, have been already mentioned in speaking of the joint of the wrist, as separating it from the articulations of the carpus. They are of close condensed texture, passing between the bones from before backwards, one joining the scaphoides to the lunare, the other this last bone to the cuneiforme. They are very narrow, the upper side smooth, covered by synovial membrane forming a polished surface with the convexity of these bones, with the edges of whose cartilages they are continuous. The os pisiforme is placed without the ranks of the carpal bones, and has no communication with the common joint between them. It rests by a slightly concave articular surface on a corresponding convexity of the cuneiforme; the joint is lined by a synovial membrane reflected from one to the other, strengthened by scattered ligamentous fibres. Two bands of these, of considerable size and strength, pass from the lower side of the bone, one to the root of the metacarpal bone of the little finger; the other to the os unciforme. The pisiform bone is retained in its situation by these, and, in some measure, also by the abductor muscle of the little finger, to

which it gives attachment. Above we observe some ligamentous fibres passing from it to the ulna, and the insertion of the flexor carpi ulnaris. It performs the office of a patella, or sesamoid bone, for this latter muscle "positum porrectumque inter ejus tendinem, ligamentumque ad os metacarpi digiti auricularis pertinens." Its motions are very limited; it forms, together with its connections above and below, a large portion of the channel through which the flexor tendons glide.

To form the articulation between the first and second row we find the scaphoides touching the trapezium and trapezoides, forming, in conjunction with the lunare, a cavity for the reception of the head of the os magnum, and the cuneiform bone supporting the unciforme. The respective articular surfaces are covered by a thin crust of cartilage, and preserved in their situations by palmar, dorsal, and lateral ligaments. The palmar ligaments are short and strong, formed by fibrous bands, passing from one row to the other in different directions; the most superficial are confounded with the anterior ligament of the wrist. The dorsal ligaments resemble them in their passing from the upper row to the lower, but are too irregular in size and direction to allow of specific descriptions. Indeed they are both so mixed with the surrounding ligamentous fibres as scarcely to admit of distinction. Of the lateral ligaments, the external is the shortest and strongest, passing from the scaphoides to the trapezium; the internal stretched between the cuneiforme and unciforme.

The bones of the second row are in contact by cartilaginous surfaces, and connected by ligaments, as those of the first. The dorsal transverse ligaments, are very distinct, one between every two corresponding bones; the palmar are not so well defined, the fibres of each being shorter and more numerous, as they are more deeply seated. We can observe one band, passing from the trapezium to the os magnum in front of the trapezoides, independent of those between the contiguous bones. Between the unciforme and os magnum is a strong collection of fibres passing from side to side through the depth of the carpus, adhering firmly to such parts of the corresponding bones as are not covered by cartilage. A similar connection exists also between the os magnum and unciforme.

The synovial membrane is continued from one articular facet to another, lining the ligaments we have described, appearing in many places between their fibres. Nor does it form a continued surface only between the carpal bones, it is extended below into the joints, between the carpus and metacarpus; not always, however, into those formed above by the os magnum and unciforme. Owing to this general communication, disease of one articular surface is presently propagated to the whole; in this respect it must be considered only as a single joint.

The pisiform bone is in nowise concerned in the mechanism of the carpus; its uses have been mentioned above. So closely are the bones of each row bound one to another, that they allow of scarcely any perceptible gliding motion. The articulations between the two rows allow of a more sensible movement; though this is confined to narrow limits. It resembles somewhat that observed in the joint of the wrist; they can be bent, and extended a little on each other, as well as inclined laterally; the first of these is the most evident. The little motion they possess is produced principally by the articulation of the head of the os magnum, which has the greatest effort to sustain, and has been sometimes luxated backwards. Notwithstanding the obscurity of movement in the carpal bones, it co-operates in increasing the mobility of the hand, whilst at the same time, by the num-

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ber of articulating surfaces, impulses may be to a certain degree weakened.

Before we enter on the latter point, it will be proper to take some notice of another ligament, materially affecting the solidity of the carpus, though destined but in a secondary way for this purpose, its first office being to confine the flexor tendons in their passage to the fingers. The annular ligament in front of the wrist, (*ligamentum armillare*, *ligamentum carpi proprium*,) passes from the eminences formed by the pisiform and-unciform bones to the opposite ones of the scaphoides and trapezium, completing the canal for the flexor tendons. It is composed of very strong and thick fibres, becoming gradually thinner above and below; rough superficially, lined behind by a synovial bursa. It gives attachment to several muscles of the thumb and little finger. The fibres are all transverse, numerous and compact, securing, in addition to its other uses, the arch formed by the carpal bones. The carpus then derives its firmness from the large surface of the articulating facets in comparison with the smallness of the bones, from their number, from the numerous ligaments, and from the arched form resulting from the connection of the whole. It is further strengthened by numerous tendons, the flexors in front, the extensors on its dorsal surface. Another cause of the solidity of the carpus is, that the articulations between the two ranks are not in the same transverse line, the unciforme, and more especially the head of the os magnum, mounting far beyond the level of the trapezium and trapezoides, so that any impulse would not act on all at once, and cause a general displacement, the effort and the injury must be partial, confined to the articulations between one or two of the bones.

The *metacarpus* (*die mittelhand*, Germ.) - is composed of five bones, resting on the carpus above, giving support to the thumb and four fingers below. They are strong, those supporting the fingers parallel to each other, the other a little anterior, and capable of altering its position. The intervals between them are filled by muscles so as to form a broad and solid body. The anterior face of the metacarpus is concave, constituting the palm of the hand, the posterior convex, and forms the back. The bones are distinguished, from the connections below, into the metacarpal bones of the thumb, the fore, the middle, the ring, and the little fingers, or we class them numerically, beginning on the radial side with the metacarpal bone supporting the thumb. Of these divisions we shall adopt the latter. The first metacarpal is the largest, and shortest of the whole; the second and third are nearly of the same length; the fourth and fifth are successively shorter and smaller. They are all somewhat concave before, and flat behind, presenting several more or less acute angles; larger at each extremity, the upper angular and unequal, the lower forming a convex head, compressed laterally, with an articular surface terminating on the palmar side in two prominent points; smallest in the middle of the body of the bone, increasing gradually in size above and below. In considering the distinguishing characters of each metacarpal bone, we shall observe them as seen on the carpal extremities, the bodies, and the digital extremities of each successively, and not tire the reader by a separate description of the several bones, in which it would be impossible to avoid repetition, and which must necessarily be of greater length.

At the upper or carpal end of the first metacarpal bone we observe an articular surface convex transversely, slightly concave in the opposite direction, opposed to the trapezium. It is surrounded by ligaments, and gives attachment on the outer side to the extensor ossis metacarpi pollicis.

In the second are three articular surfaces, the middle

concave, corresponding to the prominence of the trapezoides; the external small and flat, articulated with the trapezium; the internal divided into two portions, the upper articulated with the os magnum, the lower with the following bone. The circumference of this extremity is rough, and gives attachment to ligaments. On the palmar side is a rough spot, which gives attachment to the flexor carpi radialis; on the dorsal a tubercle, into which the extensor carpi radialis longior is inserted.

In the third a quadrilateral articular surface opposite to the os magnum, bounded before and behind by inequalities, giving attachments to ligaments; on the outside by a smooth facet articulated with the preceding bone; on the inside by two small round articular surfaces, separated by a hollow contiguous to the following bone. At the external dorsal angle is a pyramidal eminence (*processus styloformis*), and close on the inner side the insertion of the extensor carpi radialis brevior.

In the fourth, at the top, a double articular surface, accommodated to those of the os magnum and unciforme, surrounded before and behind by rough points for ligamentous attachments, on the outside by two prominent articular facets, corresponding to those of the last bone; on the inside by a slightly concave surface articulated with the following.

In the fifth, a broad articular surface, convex from before backwards, concave transversely; slanting outwards and upwards, opposed to the unciforme, bounded before and behind by rough surfaces for ligaments, on the outside by a small articular facet connected with the last bone on the inside by a tubercle which gives attachment to the tendon of the extensor carpi ulnaris.

The bodies of the metacarpal bones are all concave anteriorly, and slightly convex on their dorsal surface. Although rather irregular in figure we can distinguish in them four sides, an anterior, a posterior, an internal, and external. In the first the posterior surface is broad; in the three next we observe above a prominent line running lengthwise, which soon bifurcates, forming the lateral boundaries of a flat triangular surface, the breadth of which increases as it approaches the digital extremity; in the last an angular line, running diagonally from the inner side of its carpal end to the outside of its lower extremity. In all of them the posterior surface is covered by the extensor tendons.

The anterior or palmar surface presents also a longitudinal rising line, generally more prominent towards the lower end. It separates the attachments of the interossei muscles, and has somewhat different directions in the several bones. In the first rounded, covered by the opponens, and flexor brevis pollicis; in the third giving attachment above to the latter muscle, below to the adductor pollicis. The lateral surfaces of these bones are broad, inclined obliquely in various directions, giving attachment to muscles. In the first they are compressed and rounded, the outer side giving attachment to the opponens, the inner to the first external interosseus (the abductor indicis of Albinus). In the last the inner or ulnar side gives attachment to the adductor ossis metacarpi minimi digiti; the outer side, as well both sides of the other metacarpal bones, give attachment to and are covered by the external and internal interosseous muscles.

The digital extremities are in all convex, and nearly alike in figure. On the palmar side of the first we observe two slight depressions corresponding to the sesamoid bones in front of the joint; on the sides of the articular surfaces of each deep hollows for ligaments, which secure the articulations between these bones and the fingers.

The metacarpal bones resemble in structure and formation

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the other long bones. At the period of birth the extremities are cartilaginous, ossification commencing in the body of the bone in the embryo of three months.

In the preceding description we have reckoned five metacarpal bones, according to the plan followed by the most eminent anatomists. By many the first metacarpal bone has been omitted, and described as the first bone of the thumb, which they consider as composed of three bones, like the fingers. By Albinus the metacarpus is divided into two portions, one, comprising the four last bones, he calls the metacarpus manus; the other, the metacarpus pollicis.

The articulations between the bones of the carpus and metacarpus are nearly similar in all but the first. The articular surface at the upper end of the metacarpal bone of the thumb is convex and concave in opposite directions, adapted to the corresponding surface of the trapezium. The joint is surrounded by ligamentous fibres passing from one bone to another, amongst which the external and dorsal are the most strongly marked, and the most in number, the internal and anterior are continued on to the annular ligament. It is lined by a distinct synovial membrane. The disposition of the ligamentous fibres is such as to form a capsule round the articulation, like that observed in the shoulder joint, but not so loose. The whole is supported by the muscles and tendons of the thumb. The second metacarpal bone is articulated with the trapezium, the trapezoides, and the os magnum; the third with the latter only; the fourth with it and the unciforme; the fifth with the last alone. The surfaces are covered by cartilages continuous with those forming the joints between the metacarpal bones themselves, and lined by a common synovial membrane with occasional exceptions, as mentioned when speaking of the carpus. The ligaments on the dorsal surface pass in different directions from the lower row of carpal bones, to the upper end of those of the metacarpus. There are two for the second of these, one from the trapezium, the other from the trapezoides; the third has but one from the os magnum; the fourth two, passing from this bone and the unciforme; the fifth a single band from the latter. They are all short, flat, and compact. The palmar ligaments are less distinct, being confounded with those around them. The most evident are, a band passing from the trapezium to the third and fourth metacarpals, confining in its passage the tendon of the flexor carpi radialis; and a band between the trapezium and first metacarpal.

*The articulations of the metacarpal bones between themselves.*—The metacarpal bones, with the exception of the first, touch at both ends by lateral articular facets, which have been already described. The synovial membrane lining those at the carpal extremity is open above, forming a free communication with the carpus. They are secured in their relations by transverse ligaments at both ends. At the carpal end these are found on the palmar and dorsal surfaces; on the first of these the superficial ligaments form a continued layer, passing from the second to the last, the more deeply seated passing from bone to bone. The dorsal ligaments pass across between each bone. Besides these, we find immediately below the articulations strong ligaments passing deeply between the bones, uniting them most firmly together. At the digital end is a strong transverse ligament on the palmar side, the superficial fibres passing from the first bone to the last, those more deeply seated between each individual bone. It is covered in front by tendons and vessels, behind it supports the interossei muscles, and is united to the ligaments connecting the metacarpus with the fingers.

Among the bones of the metacarpus, the first enjoys very extensive motions in every direction. The most important

motion is that which brings the thumb in opposition to the fingers, and enables us to grasp the object before us; an office which made Albinus bestow on it the emphatic name of “*manus parva majori adjutrix.*” The freedom of this motion depends on the extent and obliquity of the articular surfaces, between it and the trapezium, and is favoured also by their being on a plane anterior to the rest of the hand.

Circumduction of the thumb is very free towards the palm, very much less so in the opposite direction. The interval between this and the other metacarpal bones is highly advantageous in allowing of all its motions. The four last bones of the metacarpus are bound so closely together, as to allow of much individual motion. They can be brought closer together below, and bent a little forwards, so as to increase the hollow of the hand; this motion is most evident in the two last, those of the ring, and little fingers. The four last bones of the metacarpus hold a middle rank, as to motion and solidity, between the carpus and fingers; above they partake of the firmness of the carpus, below approach nearer the mobility of the fingers.

*The fingers, including the thumb,*—are five in number. They are either reckoned numerically from the radial to the ulnar side, or distinguished by proper names. The latter are in common acceptation. We count, therefore, the thumb as the first; the fore-finger or index as the second; the middle finger as the third; the ring finger as the fourth; and the little finger as the fifth. By this arrangement we can immediately compare their relations to the metacarpal bones, which have been described also in a similar numerical order. The fingers are composed of rows of long bones, placed vertically one beyond another, called *phalanges*; of these we find three in the fingers, properly so called, and two only in the thumb, the middle phalanx being wanting. They are distinguished by the names of the first or metacarpal phalanx, the second or middle, and the third or unguinal. As the corresponding bones of the several rows are essentially alike in all, we shall include them in one description, noticing the peculiarities of each. We divide them into two extremities, and a body.

*The first, or metacarpal phalanges,*—are the largest, and longest of the three; of different lengths and size, the third being the longest, and all diminishing successively in volume from the first to the last. They are convex on the dorsal surface, the transverse convexity forming nearly half a circle; concave anteriorly, with sharp angular edges laterally. At the superior extremity we observe an articular surface, oblong transversely, slightly hollowed, articulated with the corresponding bone of the metacarpus; a broad tubercle on each side giving attachment to lateral ligaments, divided anteriorly by a depression, in which the flexor tendons pass. In the thumb this extremity gives attachment to the abductor, the flexor brevis, and the adductor. The bodies of the phalanges are convex posteriorly, covered by the extensor tendons; concave on the palmar side with projecting edges, so as to form a kind of gutter, in which the flexor tendons are partly lodged; the edges give attachment to ligamentous sheaths confining the tendons in their situation. The lower extremity offers an articular pulley, extended further and much broader on the palmar side than on the opposite, and the edges diverging considerably from behind forwards. On each side are depressions, which give attachment to lateral ligaments.

*The second, or middle phalanges,*—are smaller and shorter than the first, which they resemble much in general figure. The thumb possesses none. As to individual comparison, they differ but little, that of the middle finger is the longest, the last belonging to the little finger the shortest and

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smallest. The upper extremity offers an articular surface crossed antero-posteriorly by a rising line, corresponding to the opposite pulley of the first phalanx; on each side are tubercles giving attachment to ligaments. The body resembles that of the metacarpal phalanx. About the middle of the anterior surface are two rough prominences, giving attachment to the divided tendon of the flexor sublimis, and to a fibrous sheath, which crosses over it from side to side, confining also the tendon of the flexor profundus. Its posterior surface gives attachment to a portion of the tendon of the extensor communis. The lower extremity resembles that of the first.

*The third, or ungual phalanges*—are found, in all, five, diminishing in size from the thumb to the little finger, that of the former being by far the largest of the whole. The upper extremity or base (from a comparison of the bone to a pyramid with its apex downwards), forms an articular surface, oval transversely, with a convex line crossing from before backwards, accommodated to the pulley of the middle phalanx; is tuberculated for ligaments on each side, giving attachment behind to extensor tendons. The body is contracted; on its anterior surface the flexor profundus is fixed in the fingers, and flexor longus in the thumb. The lower extremity, or point, is flat, rounded, broader than the body, scabrous at the edges and on the anterior side, smoother behind, where it supports the nail.

The bones of the fingers have nothing peculiar in structure or formation: the first and second phalanges are formed from three ossifying points, the third from only two. At the time of birth, their figure is well marked, and their formation very considerably advanced.

*The articulations of the thumb and fingers with the metacarpus.*—The convex heads of the metacarpal bones are covered by articular cartilages, in contact with those lining the concave surfaces of the first digital phalanx. They are bound together by lateral ligaments, and strengthened in front by the sheaths of the flexor tendons, behind by the expansion of the extensors, on each side by the interossei muscles. The lateral ligaments are attached above to the sides of the lower end of the metacarpal bones, and divide as they descend into two distinct bands, which are fixed to the sides of the corresponding bones of the first phalanx. They are strong, formed of parallel fibres, lined on the inner surface by the synovial membrane. In front of the joint we find the transverse ligament of the lower end of the metacarpus, which has been already described. The synovial membrane is loose, particularly before lining the extensor tendon in its passage behind over the joint, and appearing between the ligaments, which it also covers in front and on the sides. In front of the joint of the thumb we find two sesamoid bones developed in the tendons of the flexor brevis, leaving a furrow between them, in which the tendon of the flexor longus passes. They rest on the head of the metacarpal bone, gliding up or down, as the joint is bent or extended. They are sometimes found in the articulations between the metacarpus and fingers. The motions enjoyed by this joint are those of flexion, extension, abduction, and adduction; of these the first is by far the most considerable, the thumb possessing it in the least, the little finger in the most extensive degree.

The articulations between the phalanges are alike in all; the condyles, at the lower extremities of the first and second phalanx, are covered by cartilage, and correspond to the little hollows at the upper ends of the second and third. They are covered by a synovial membrane, and connected by lateral ligaments, which pass from bone to bone, resembling those of the preceding articulation. The synovial

membrane is supported by these, as also by the extensor and flexor tendons. It is so closely united to the extensor tendon, at the upper end of the second and third phalanx, that it is almost impossible to separate them. It is continued much further down on the bone on the palmar, than on the dorsal surface, forming a little bag in front of the joint. The thumb has but one of these articulations, which is in every respect similar to the joints between the phalanges of the fingers.

In this last part of the hand we observe an evident decrease of firmness, when compared with the metacarpus and carpus, and a proportionate increase of facility and extent of motion. The shortness of the bones, however, scarcely offering a resisting point to external impulses; secures their relations, and lessens the chance of fracture, though the fingers are more immediately within the action of surrounding bodies, and more exposed to injuries than any other part of the limb. The joints of the phalanges of the thumb and fingers allow only of flexion and extension; the latter cannot be carried beyond the straight line, the former is very free; an effect which depends on the continuation of the articular surfaces in front, far beyond their extent on the dorsal surface, and which is provided for by a corresponding laxity of the synovial membrane. The advantages of this disposition, for the important functions of the fingers, is so conspicuous as to require no comment. In opening the hand, the fingers cannot be extended beyond the plane of the hand; from this situation they may be bent in various degrees, until their points touch the lower end of the metacarpus. This general flexibility, derived from the successive rows of firm bones, and their peculiar modes of articulation, allows of the fingers being applied accurately to any body whose qualities we wish to examine, whatever be its figure. The decreasing length and size of the several phalanges permit us to seize objects conveniently and firmly; to retain them, however small. The power we possess of moving them singly, or in different degrees, of touching the palm of the hand at any point of its surface, of spreading them laterally, of separating one from another, &c. enables us to adapt their position to every possible use. In all the actions of the hand, the thumb holds a conspicuous rank. Alone, it opposes the efforts of the other fingers; which are much longer, and bend, as it were, to meet the thumb, whenever we close them on the object. With regard to the different lengths of the thumb, and several fingers, we may observe, that when separated most widely from each other, by gently bending the points they may be brought to describe nearly a circle on a plane surface, forming with the hollow of the palm a concave hemisphere; from which situation they may be further contracted, till the several points meet: from this construction they are suited to grasp equably and firmly bodies of a rounded form. The sense of touch owes, in a great measure, its delicacy and perfection to the readiness and precision with which the fingers can be applied to the object whose qualities we wish to examine. It would be almost endless to describe the different motions of which they are susceptible; they are so rapid in succession, so varied in direction, extent, and power, so exquisitely adapted to the innumerable offices they have to perform, as to constitute an inexhaustible, not to say an inexplicable subject for discussion.

We conclude our history of the upper extremity, by some remarks on its powers of resistance and susceptibility of motion, as a complete member, enjoying the assemblage of all the properties we have described as resulting from the mechanism of each division.

The cases in which the upper extremities are required to support

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support great efforts, or to oppose a powerful impulse, are by no means so numerous or so frequent as in the lower limbs, where considerable exertion and resistance are necessary, to support the body in the ordinary attitudes. In the action of pushing, the hand is applied to an object, the fore-arm and arm extended between it and the trunk forming a straight lever, which conveys the weight of the latter on the body to be pushed. In this motion the hand being inflected backwards on the fore-arm, the joint of the wrist is soon fatigued by the distension and pressure in front; the sigmoid cavity of the ulna bears directly against the lower end of the humerus, the latter rests on the glenoid cavity of the scapula, which is fixed firmly by its muscles and the clavicle.

It is only, however, when the arm is directed outwards, that it bears directly on the glenoid cavity; if it be turned forwards or backwards, the capsular ligament and the surrounding muscles sustain the effort. The first circumstance is most favourable to firmness and continued resistance; and we may observe, that when at liberty to choose our attitude in pushing with one arm, we always place it in such a direction as to bring it to bear directly on that cavity. For instance, if the object be in front, we turn ourselves so as to bring the side of the body corresponding to the limb we are about to exert opposite to the object. In pressing downwards, in resting on the arm, &c. the mechanism is nearly the same, as far as regards the hand, which is so much extended on the fore-arm as to form an angle with it behind, while the fore-arm is placed in the same line with the arm, the joint of the elbow being fixed and immovable. The difference depends only on the change of situation which takes place in the joint of the shoulder, the head of the humerus pressing more or less advantageously, as the direction of the pressure varies from the relative position of the object on which the limb rests.

The best possible direction is where the arm is extended laterally, so as to bear on the glenoid cavity, the scapula being at the same time supported directly by the clavicle. It is understood that in every case the position of the limb is preserved by muscles, which are called on to act more or less, as that position is more or less favourable for sustaining the effort, and become tired in the same proportion. This observation is more particularly applicable to the case in which the upper extremities have to sustain the whole weight of the body, as in the instance of tumblers, when the hands are placed on the ground, and the body raised into the air, the upper exerting for a time the functions of the lower extremities. This attitude is both difficult and painful, from the want of sufficient muscles to maintain it, and from the small extent of the articular surfaces. The wrist suffers more particularly, as in marching on all-fours, because these surfaces do not bear on each other, but on the front of the joint; the elbow is not so much distended from the construction of the articulation; the shoulder-joint suffers almost equally with the wrist, from the pressure on its capsule. The upper extremities are articulated with the trunk in a plane posterior to the lower; the line of gravity in the attitude above-described is anterior to the support, and we find, consequently, that to preserve the balance, to counteract the tendency to fall forwards, the lower extremities are thrown considerably backwards.

The motions of the upper extremity are so numerous and varied, as scarcely to admit of classification; they are so familiar as not to require description. The mechanism by which they are performed has been considered in treating of the several articulations, and may readily be applied to any case; we shall now only briefly recapitulate the more mate-

rial points. The shoulder is the centre of motion of the whole limb; the arm gives the general movement, the parts below those which are more partial. The motions of the shoulder affect the whole limb; as we descend, the actions are more and more confined. A finger may be employed while the arm is motionless; if the latter is moved, all below must partake of the motion. It is from the combination of the several partial motions that the increase and variety of the whole are derived, and these are multiplied the lower we go. The hand enjoys the individual motions of its component parts; a general motion from the joint of the wrist; a more general still from the connection of the bones of the fore-arm and the elbow, which is increased to a still greater extent by the shoulder joint and shoulder. The motions then may be more compound as we descend, as well as more partial, because each part enjoys the motion resulting from its proper articulation, in conjunction with all those above it. This general action of the parts of the upper extremity is observable in seizing or grasping any body, or in embracing, where all the articulations are bent, or in the opposite actions of spreading the arms, or extending the whole limb in different directions, &c. It is more commonly seen under cases where the different joints are inflected variously at the same time, some extended, and others bent, these motions being often alternate. All these modifications of action may be observed in pushing, pulling, climbing, grasping a distant object, swimming, striking, &c. &c. In short, in all the familiar exercises of the upper extremity we are constantly in the habit of performing. We cannot conclude without hinting at those impressive actions of the upper extremity, which form a mute language employed most emphatically in aiding the expressions of our passions, or our will; it is enough to say, they are as numerous and varied as the feelings which bring them into play.

*The lower extremity*—is divided, as the upper, into four parts, viz. the hip, the thigh, the leg, and the foot, each of which has a more or less striking analogy with the corresponding divisions of the upper extremity. We shall examine their points of resemblance and difference more minutely hereafter; at present, we would observe only, that the bones, which form the basis of the lower extremity, are more massy and solid in their forms, and are hence adapted to their functions, as organs by which the rest of the body is supported and moved. Their prominent character is solidity and firmness; in the upper extremity every thing is constructed for variety and quickness of motion.

The lower extremity is connected with the trunk by the articulation of the hip bone with the basis of the vertebral column, the sacrum; through which the whole weight of the body is transmitted to the bones of the hip. The connections of the two hip bones with the sacrum behind, and with each other in front, form a bony cavity called the *pelvis*, the principal uses of which are, to contain some important viscera, to offer a basis of support to the trunk above, and two fixed points for the motions of the limbs below. It is in the last functions only that we shall have occasion to notice the pelvis here; we shall not, therefore, enter into a description of it as a whole; but attend to those of its parts which bear on the present subject, and correspond to analogous portions of the upper extremity.

The *os coxae*, *os innominatum*, hip, or haunch bone, is the largest of the broad bones, placed laterally at the lower end of the trunk, connected with its fellow in front, by means of cartilage, and separated from the opposite bone behind by the intervention of the sacrum. The hip-bone is very irregular in figure, broad and flattened above, con-

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tracted and massy in the middle, and apparently more slender in the anterior and lower portions: it is curved so as to have its flat surfaces in almost opposite directions; the upper division is flattened from side to side, the lower from back to front, the change of direction taking place in the middle portion. In young subjects this bone is formed of three separate pieces; a superior, called the *ilium*, an anterior, the *pubes*, and an inferior, the *ischium*. In the adult they are so intimately united, that we can with difficulty trace their former line of separation. We can see therefore no reason for describing as distinct, what in its perfect state forms but one solid bone. We shall consider it as such; but, not to deviate too much from common usage, shall notice the different divisions as we proceed, and afterwards particularly describe their lines of union. We distinguish in the *os innominatum* two surfaces; an internal or pelvic, an external or femoral, and a circumference or border, which is again subdivided into several parts.

The external surface looks outward above, and forwards below; it is covered by strong and numerous muscles. The outside of the broad upper division, the dorsum of the *ilium*, is convex and concave in different parts; at the posterior and superior part is a rough eminence, which gives attachment to the *gluteus maximus*; below this a surface, concave and broad behind, convex and gradually narrowing in front, gives attachment to the fibres of the *gluteus medius*; it is bounded by the eminence just mentioned, by the upper edge or crista of the *ilium*, and below by a semi-circular line, with the convexity upwards, passing forwards from a deep notch behind, (the great sacrociatic,) and terminating in the crista of the *ilium* in front. The space comprised between this curved line and the deep articular cavity below, gives origin to the *gluteus minimus*; it is concave behind, and gibbous in front. At the anterior part, immediately above this cavity, is a rough impression, where the curved tendon of the *rectus cruris* is fixed. The portion of the external surface, which is directed downwards and forwards, is very irregular in figure. Above is a deep and large cavity, called the *acetabulum* or cotyloid cavity; it forms nearly the half of a sphere, lined by cartilage in its upper two thirds, the lower part a little deeper, lodging some cellular tissue, and the strong ligament passing to the head of the thigh-bone. The margin of the cavity is irregular and waving, more prominent above than below, surmounted by a ligamentous ring, which makes the *acetabulum* still deeper, interrupted towards the inner side by a notch, completed by a ligament which leaves only a small opening for the passage of the articular vessels; it gives attachment to the capsular ligament of the hip joint. The bone surrounding the cotyloid cavity is thick and massy, especially at the upper and outer sides; the cavity itself is directed obliquely outwards, downwards, and forwards. Below, and on the inner side of this cavity, is a large hole, of an oval shape, the *foramen ovale*, *obturatorium*, or *thyroideum*. Its long diameter is from above downwards, its edges are acute and rough, except at the upper part, where there is a smooth gutter directed obliquely from above inwards and downwards, in which the obturator nerve and vessels are lodged. The groove is formed by the internal and external edges of the circumference crossing each other at the top of the oval, the latter passing in front to a point called the spine of the *pubes*, leaving the oblique hollow between itself and the internal margin which passes up in the opposite direction. The *foramen ovale* is closed by a ligament attached to its edges every where but at the groove just mentioned, where it leaves a vacancy for the passage of the obturator vessels, &c. In the female this foramen is smaller than in the male,

and of a triangular figure. On the inner side of the foramen is a rough and unequal surface, broader above and below than in the middle, giving attachment to portions of the *triceps*, and the external obturator muscle.

The internal or pelvic surface is concave, corresponding in its direction to the external or femoral, covered by muscles which arise from it. The anterior part of the upper division, the *fossa iliaca*, is occupied by the *iliacus internus* muscle; the posterior is very scabrous and unequal, divided into two portions, of which the anterior is covered by cartilage, and articulated with the sacrum, forming the *sacroiliac symphysis*, resembling somewhat in outline the human ear, the posterior is convex and very rough, giving attachment to the strong and numerous ligamentous fibres which connect this bone with the sacrum above. Below the *iliac fossa*, crossing from the articular surface to the anterior angle of the bone, is a prominent angular line, forming a part of the superior aperture of the pelvis, separating the upper division from the lower. The latter presents a plane surface behind, broader above than below, giving attachment to the *obturators internus* and *levator ani*; in front of this is the *obturators foramen*, and in the inside of the latter a narrower surface corresponding to the bladder above, giving origin to a part of the *obturators internus* below.

The circumference of the *os innominatum* is exceedingly irregular, with alternate prominences and hollows, and is divided into four portions, *viz.* a superior, an inferior, a posterior, and an anterior. The superior margin bears the name of the crista of the *ilium*; is convex, narrower in the middle than at the ends, and inclined outwards. The inner edge, or *labium*, gives attachment to the *transversalis abdominis*, and *quadratus lumborum*; the external to the *obliquus externus*, the *latissimus dorsi*, and the *fascia of the thigh*; the middle convex portion to the *obliquus internus*. The anterior margin is concave, and its lower half nearly horizontal. Its union with the crista forms the anterior superior spine of the *ilium*, which gives attachment to the *tenor vaginæ femoris*, the  *Sartorius*, and the upper end of that part of the tendon of the external oblique, called *Poupart's ligament*. Below this point is a slight notch, rising again into another eminence, the anterior inferior spine of the *ilium*, from which the *rectus cruris* arises. This is succeeded by a smooth hollow, over which pass the *psaos magnus*, and *iliacus*, bounded by a protuberance called *eminencia ileo-peetinea*, into which the tendon of the *psaos parvus* is implanted, when it exists. On the inside of this there is an oblique surface, concave, triangular, with the base outwards, and the point inwards, bounded in front by a line which is continued from the external margin of the *obturators foramen*, behind by a sharp ridge, the crista of the *pubes*, which is continued from the transverse line described as crossing the pelvic surface. Over this concave space pass the crural vessels. The anterior margin terminates by uniting with the inferior, at a right angle, called the angle of the *pubes*. A little before its end we observe on it a projecting point, the spine of the *pubes*, giving attachment to the *pyramidalis*, and the external pillar of the abdominal ring, formed by the tendon of the external oblique. The inferior margin is the shortest, presenting above a perpendicular oblong surface, forming with the opposite bone, by the intervention of cartilage, the *symphysis pubis*; below this the edge is thinner, forming with the opposite one the arch of the *pubis*, affording attachment to the *gracilis*, to portions of the *triceps*, to the *corpus cavernosum*, the *transversalis perinei*, and the *erector penis*, or *clitoridis*. The upper half of this bony plate is called the descending ramus of the *pubis*, the lower the ascending ramus

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mus of the ischium. The posterior margin is the most irregular in its outline. Beginning from above we observe the angle formed by its junction with the superior margin, the superior posterior spine of the ilium, an hollow separating it from the eminence below, the inferior posterior spine; a very deep notch forming part of the sacro-sciatic notch; a sharp prominence, the spine of the ischium, giving attachment to the superior gemellus, the coccygeus, and the lesser sacro-sciatic ligament; a smooth concave surface, over which the tendon of the obturator internus plays; and a broad eminence where it joins the inferior margin, the tuberosity of the ischium giving attachment, externally, to the quadratus femoris, and the great head of the triceps; within to the great sacro-sciatic ligament, and the inferior gemellus, in the interspace to the biceps, the semi-tendinosus, and semi-membranosus.

The os innominatum is in structure like the other flat bones; the two compact tables, enclosing the more cellular parts, touch each other in the middle of the iliac fossa, and again at the depression in the acetabulum. It is developed from three points of ossification, at the angle of the pubis, the tuberosity of the ischium, and the middle of the upper division, or ilium. The union of the bony plates proceeding from these points takes place between the ilium and pubes at the eminentia ileo-pectinea; between the latter and the ischium, in the middle of the branch which forms the inner side of the foramen ovale, and the half of the arch of the pubes; between the ischium and the ilium at the great sacro-sciatic notch. The junction of the three takes place in the acetabulum, which forms the principal point of union; the ilium makes the upper part of the cavity, the pubes the anterior, the ischium contributing the principal share, and completing it at the inferior and posterior portions. The part which either bone takes in forming any of the principal features of the os innominatum will be immediately seen, by observing their lines of union with each other. At the time of birth the acetabulum, being far removed from the centres of ossification, is wholly cartilaginous, as are also the different eminences, the spines, and the cristæ. It is not till the time of puberty that all traces of cartilage are obliterated. The os innominatum is articulated with the sacrum, by the sacro-iliac symphysis; with its fellow, by the symphysis pubis; and with the thigh-bone by means of the cotyloid cavity. We shall say nothing of the two former of these connections, but that they are exceedingly strong, and the bones bound so closely together, as not to allow of any perceptible motion; we shall describe the last after having gone through the history of the thigh bone.

In commenting on the mechanism of the shoulder, we had to notice its articulation with the trunk, and the motions resulting from its peculiar mode of connection; in the present instance we find an immoveable adherence of surfaces, which allows of no deviation from one determined position. In consequence of this total want of motion, we shall not enter on the detail of the connections of the hip bone with the trunk, or with its fellow; they can influence the functions of the lower extremity no farther than by transmitting to it the weight of the body.

The oblique direction of the articular surfaces of the sacrum, which gives it the form of a wedge driven between the two ossa innominata, is well adapted to the purpose of transmitting securely the weight of the trunk to the latter bones: the stronger the depressing impulse, the more closely the surfaces are brought together; the shock must be violent indeed, which can in anywise loosen their connection. It is then through the medium of the sacrum that every effort is propagated to the two hip

bones, which in some positions are the immediate base of support, while in others they continue the impulse to the limb below. In the common attitude of sitting, the trunk is supported on the tuberosities of the ischia; in progression, or in standing, on the cotyloid cavities. These being at a distance from each other, facilitate the motions of the thighs, and increase their extent, the pubes executing one of the offices of the clavicle, in keeping the hip joints far asunder, as the clavicle does those of the shoulder. It will be seen, from the description of the hip bone, that its surfaces and circumference give attachment to numerous and powerful muscles, by far the greater number of which are destined to regulate, or to give vigour and effect to the motions of the thigh and leg, and to balance the varying weight above them.

*The thigh*—is the division of the lower extremity between the hip and the leg. It is formed by a single bone, called the *femur*, or *thigh bone*.

The femur is the longest bone of the body, the largest in volume, and the strongest. It has a considerable curve forwards, is contracted in the middle, wider and more bulky at each extremity, one of which is called the upper, or *iliac*, the other the lower, or *tibial*.

The upper extremity includes three remarkable eminences; the head, supported by a long neck, and the great and little trochanters. The rounded head of the femur is received into the cotyloid cavity of the os innominatum; it forms more than half of a sphere, directed upwards, inwards, and a little forwards; so that the greatest part of its convexity is above, and its axis the same as that of the neck, which sustains it. The convex surface is smooth, except just below the centre, where we find an hollow, which gives attachment to an inter-articular ligament; it extends further in front than behind, above than below, and terminates in a waving line at the neck. The latter contracts immediately below the head, and becomes a little flattened vertically, the upper edge remaining the widest; it is longer below and behind, on which aspects it is also hollowed, than above and in front; joined by a broad basis to the body of the bone, from which it stands off in a direction slanting upwards and inwards, advancing at the same time a little forwards, forming with it an angle more or less obtuse. The length and obliquity of the neck vary considerably in different subjects, being in some nearly horizontal. The great trochanter is on the outer side, directed a little backwards, below the level of the head, rising above the hollow of the neck, quadrilateral, convex on the outside, and excessively rough for the attachment of strong tendons, the tendon of the gluteus maximus passing over the smooth surface at the posterior part; hollow, and of much less extent on the inside, giving attachment above to the tendons of the gemelli, the obturator internus, and the pyramidalis below, and towards the back part to the obturator internus. It has rough and irregular borders; to the anterior is fixed the tendon of the gluteus minimus; to the lower part of the posterior the quadratus; to the upper the gluteus medius; to the lower the vastus externus. The attachments of these muscles are hardly, however, confined to the edges of the trochanter; their tendons are implanted also to a greater or less extent over the outer surface, for which purpose its roughness, as mentioned above, seems particularly designed. The little trochanter is placed at the internal and posterior part of the base of the neck, oblong and somewhat pyramidal in shape, its rough summit giving attachment to the united tendon of the psoas magnus and iliacus. From its base we trace two prominent lines proceeding obliquely upwards to the great trochanter, one uniting them

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them in front, the other behind. These, in conjunction with the two trochanters, mark the circumference of the basis of the neck, and give attachment, more especially the anterior, to the capsular ligament of the hip joint. The body of the thigh bone is convex forwards, and hollowed behind, appearing nearly cylindrical when viewed in front, but almost triangular above, and flattened transversely towards the lower end. It has been divided in descriptions into three surfaces and as many angular lines; these characters, however, are not strongly marked; the surfaces are universally smooth, the dividing lines blunt and rounded, if we except the posterior ridge formed by the union of the internal and external surfaces, called with great propriety the *linea aspera*, or *spina femoris*. This is formed by two converging rough lines, commencing from each trochanter above; that which proceeds from the trochanter major is the most prominent and rough, giving attachment to the *gluteus maximus*; the *pectineus* is affixed to the other; and the interspace is occupied by the *quadratus* and a portion of the *triceps*. The double ridge, formed by the approach of the two rough lines, is continued down the bone, when it again divides into two less remarkable lines, which terminate in the condyles at the lower extremity. The whole middle of the *linea aspera* gives attachment to the *triceps*; a portion of the *biceps* has its origin at the lower part, which is continued along the line diverging towards the external condyle; the line going to the internal condyle is scarcely observable for a little way below the point of bifurcation. These two branches of the *linea aspera* leave a triangular interval between them, smooth and somewhat concave, corresponding to the popliteal vessels. Besides the muscles fixed to different parts of the *linea aspera*, the *vastus externus* is attached to almost the whole extent of the line, proceeding from the great trochanter to the external condyle; and the *vastus internus* is connected in a similar manner to the line from the little trochanter to the internal condyle. The surfaces of the body of the femur are covered by these muscles, and by the *crureus*, which cover the bone at every point, excepting towards the lower end, and the space intercepted between the bifurcation of the *linea aspera*. The nutrient arteries of the body of the bone are found in the course of the *linea aspera*; the principal one about the point of convergence above.

The lower extremity much exceeds the upper in volume, and presents two eminences called condyles, the internal and external. They are both convex, project more behind than in front, are smooth below for articulation with the tibia, this surface being terminated behind by two hollows, which give origin to the heads of the *gastrocnemius*. They diverge behind, leaving a deep notch between them, where the crucial ligaments of the knee joint are fixed; on the front they are joined by a continued articular surface, which is hollowed to receive the knee-pan or patella; the edge of the pulley formed by the outer condyle being more elevated than the opposite one. The articular surface terminates abruptly in the lateral direction, in the perpendicular rough sides of the condyles; in front it is continued a little way up the bone, ending in a slightly prominent edge. The internal condyle gives attachment on the inner side to a lateral ligament, and to the tendon of the *triceps*. The external surface of the outer condyle is marked by a depression to which the *popliteus* is affixed, and by an eminence for the external lateral ligament of the knee. The articular surface of this condyle is broader than that of the internal, and not so convex, the anterior part being nearly plane; and it is continued much higher up in the front than on the opposite side. The internal condyle, when the

thigh bone is placed perpendicularly, appears to descend much lower than the external; but in the natural oblique direction of the femur, the bottom of the two condyles will be found nearly in the same horizontal plane, the internal still exceeding a little.

The femur is compact in its structure in the middle part, reticular and spongy at the extremities, which are yet cartilaginous at the time of birth. Ossification commences in the middle of the bone, and it is not till after this has reached the extremities that we observe three centres of ossification above, in the great, the little trochanter, and the middle of the head, and two below, one for each condyle. The cartilages between them and the body of the bone gradually decrease in thickness, and they become united, the two trochanters the first, then the head, and last of all the conjoined condyle. It is not till the bone has nearly arrived at its complete and adult form that the line of separation is entirely obliterated. In infancy the neck of the bone is nearer at right angles to the body than at any after period; as the age advances the angle becomes more and more obtuse in the majority of subjects; in some few it scarcely alters its direction. This alteration, from an horizontal to an oblique line, is a proof among many others how little the functions or growth of the animal body are subject to physical laws; we see the neck of the thigh bone rising, as it were, in direct opposition to the weight of the super-incumbent body. This portion of the femur is also proportionally shorter than in the adult, and wholly cartilaginous. The body of the bone is straight, instead of being curved forwards, as in the adult; and the inferior extremity is comparatively of larger dimensions. These characters of the infantile bone are lost as it gradually becomes developed, and acquires its remarkable density and firmness. The thigh bone is articulated above with the *os innominatum*, below with the tibia and patella.

*The articulation of the femur with the os innominatum, the hip joint.*—The surface of the cotyloid cavity of the hip bone is lined by an articular cartilage, of which the central parts are thinner than the circumference. It terminates at the edge of the depression observed at the inner and lower parts of the cavity, which is filled up by a fatty cellular tissue, supplied by numerous vessels. The bony margin of the cavity is completed by a ligament crossing the notch, and the whole rim of the acetabulum is surmounted by a circular ligament, called the cotyloid ligament; which much increases its depth. In this round articular cup, or acetabulum, the head of the thigh bone is lodged. The latter is covered by cartilage thinner at the circumference than towards the centre, where it is partially interrupted by the insertion of a ligament, and accommodated exactly to the opposite surface of the acetabulum; the cartilaginous head, however, is so deep as not to be wholly embraced by this cavity in any position; and hence some part of its margin always appears exposed on turning back the enveloping ligament. The contiguous surfaces are secured in their relations by a very strong capsular ligament, supported by fibres from the neighbouring parts, and surrounded on all sides by muscles; and by an inter-articular ligament. The opposed surfaces are covered by a synovial membrane.

The cotyloid ligament adheres firmly to the edge of the acetabulum at every point, excepting the great notch which it crosses. It is thick at the border next the bone, thin at the opposite prominent margin, broader above, and externally thin in the contrary directions, and partially broader wherever there is any depression in the osseous rim, so that the unconnected margin of the ligament is exactly plane throughout. It is formed by ligamentous fibres arising from

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from the edges of the cavity without, inclining gently towards it in their progress, and inserted again into the sides of the margin within at a greater or less distance from their point of origin. These fibres receive an addition above from the curved tendon of the *rectus cruris*; below they are confounded with the fibres of another ligament, completing the great notch. The latter is formed by two cross planes of fibres passing from one edge to the other; they decussate each other in their course, one band corresponding to the surface of the joint, the other to the edge of the obturator foramen, from the ligament occupying which it partly takes its origin. They leave a vacancy below for the passage of vessels into the joint; towards the brim of the cavity they are continuous with the cotyloid ligament in the manner above-mentioned; they give a partial attachment also to the ligamentous capsule. The cotyloid ligament, in conjunction with these bands, completes the figure of the acetabulum, and by increasing its depth secures the joint without in any degree diminishing the motions of the head of the femur, to the pressure of which it readily yields. They are both lined towards the joint by the synovial membrane, which is continued over the edge of the cotyloid ligament a little way down the opposite surface, before it is reflected to the capsular ligament. These two last are opposed to each other in part by its intervention; towards their mutual attachment to the brim of the cavity they are intimately united. Into the articular hollow thus constituted, the head of the femur is received, and secured by an orbicular and internal ligament.

The capsular ligament of the hip joint, (*l. orbiculare, membrana capsularis femoris, Soemm.*) extends from the circumference of the acetabulum to the base of the neck of the femur. It is fixed to the bony margin of the former from the line of insertion of the cotyloid ligament, to a short space beyond it, so as to surround the latter, which projects freely into the joint. Its insertion extends further beyond the cotyloid ligament in front and on the outer side than it does internally, where it may be almost said to arise from its very edge. From this circular attachment the capsule descends, enveloping in its course the chief part of the neck of the femur, to the circumference of whose base it is finally fixed. In front it reaches the oblique line between the trochanters, the *linea inter-trochanterica*; behind, some of its fibres only reach so far, the greater number are implanted into the neck between the posterior oblique line and its middle; above, it is fixed to the root of the great trochanter; below, it extends nearly to the little. The capsular ligament is in general very thick, and of a close and condensed texture; it is thinnest internally and behind, thicker externally, and most decidedly so in front, where it is strengthened by a layer of longitudinal fibres arising from the anterior margin of the *os innominatum*, and from the anterior inferior spine, and fixed below to the anterior *linea inter-trochanterica*. In other parts of the ligament the course of the fibres is less distinctly marked; from the margin of the acetabulum they follow different directions, decussating each other, and leaving occasional intervals, more especially below, through which vessels pass to the synovial membrane. This last is occasionally exposed and bare on the side next the obturator foramen. The capsular ligament is covered in front by the *rectus cruris*, *psoas magnus*, and *iliacus internus*, a synovial bursa lying between them; on the internal side, by the *obturator externus* and *pectineus*; behind, by the *quadratus femoris*, the gemelli, the tendon of the *obturator internus*, and the *pyramidalis*; above and without, by the *gluteus minimus*, which is more closely connected with it than any other of these muscles.

The interior, or round ligament, (*ligamentum teres, internum*) is entitled to almost any name rather than round; it is flattened, and of a triangular figure, the base towards the acetabulum, the summit next the head of the femur. It is fixed at one end to the extremities or corners of the great notch of the cotyloid cavity, and to the posterior edge of the transverse ligament occupying the vacancy; from thence it mounts obliquely backwards, and is attached to the depression noticed towards the centre of the head of the thigh bone. It appears as if composed of two bands of fibres, one arising from the superior, the other from the inferior extremity of the great cotyloid notch, which approach each other towards their opposite insertion. The upper of these is by far the weakest; in many cases it appears only as a duplicature of the synovial membrane, enclosing only a small number of ligamentous fibres. It must restrain the head of the femur from quitting the cavity upwards and outwards, and must be partially, if not entirely, ruptured in the luxations in those directions; in the displacement towards the obturator foramen it would not apparently suffer much injury.

The synovial membrane lines the cotyloid cavity, is spread over the fatty cellular tissue, occupying the sinus at its bottom, is reflected from thence over the internal ligament, which it wholly encases, adhering to it more or less intimately in different parts: it covers the articular cartilage of the head of the femur, is continued over the periosteum of the neck, which appears through it as if formed of parallel fibres; at the base of the neck it turns back over the inner surface of the capsular ligament, lines it to its attachment round the brim of the acetabulum, and from thence passes over the cotyloid ligament. The hip joint is very much strengthened by the surrounding muscles, especially by those which immediately cover it.

The motions which take place in the hip joint resemble those in the shoulder; they are, however, with the exception of rotation, less extensive, owing to the immobility of the cotyloid cavity, its great depth, and the comparative tightness of its capsular ligament. The femur can be bent on the hip bone, extended, brought nearer to, or removed further from, the mesial plane, moved between these directions, or carried round in a circular direction (*circumduction*), and rolled inwards and outwards. In the most common position, with the thigh in the same line as the body, the summit of the great trochanter, which can be always felt externally under the integuments, is in the same horizontal line with the spine of the pubis, and about the middle of an oblique line extended between the superior anterior spine of the ilium, and the tuberosity of the ischium. By a previous knowledge of the relative position of this eminence to points which can be easily felt, we shall be competent to decide on any accidental displacement, as well as to follow the alteration of position in the different motions of the femur.

When the thigh is bent, the head rolls in the acetabulum in the axis of the neck, the summit of the trochanter recedes from the spine of the ilium, and approaches the tuber of the ischium, and the lower end of the bone is advanced. In moderate flexion there is but little alteration in the relations of the articular surfaces; when carried to its greatest degree, a portion of the head of the femur quits the acetabulum, and rests on the posterior part of the capsular ligament, which undergoes considerable distension. Extension of the thigh is the replacement of the limb in its former state, from the position of flexion. The very close manner in which the head of the bone is covered in front by the strong ligamentous fibres, which proceed from the anterior and inferior spine

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of the ilium, and the neighbouring anterior portion of the cotyloid line, entirely prevent us from carrying the limb backwards beyond a perpendicular line drawn from the pelvis downwards, if the latter part be preserved immoveable. The degree of motion in this direction, if it exist at all, is very trifling, supposing the trunk to be erect, and the pelvis fixed; the apparent freedom of motion in the direction of extension arises from the pelvis being ordinarily moved in the opposite direction.

In abduction, or removing the thigh from its fellow, the great trochanter rises towards the fossa of the ilium, which it touches, if the motion be continued as far as possible, and thereby limits the extent of that motion. The internal surface of the head abandons the acetabulum, while the external sinks deeper into it; the capsular ligament is made very tense on the inner side, where it supports the head and opposes its tendency to any displacement in that direction. In adduction nothing remarkable occurs; it is merely the return of the thigh from the last position to its natural one; the limb may, however, be carried, in this direction, across the opposite one. Besides these four motions in opposite lines, it will be readily understood that the femur can be moved through all of the intermediate points. Circumduction is not so free as in the shoulder joint, as may be gathered from the preceding observations: rotation is, on the contrary, less confined, on account of the length and obliquity of the neck of the femur, so strikingly different from that of the humerus. In the latter rotation is nearly in the axis of the bone, on account of the extreme shortness of the neck; in the femur, where the axis of the bone is so far removed from the centre of motion, this motion passes round a line extended from the upper part of the head to the middle point or interval between the condyles. In rotation inwards, which is more confined than that outwards, the great trochanter describes the arc of a circle from behind forwards, and the head of the bone is buried deeper in the cavity; the motion of the trochanter is more sensible and more extensive as the neck is proportionally longer. In rolling the thigh outwards the great trochanter sinks under the muscles, and the head of the bone distends the capsule somewhat in front. In its most natural position the thigh is turned a little outwards, which contributes, with the direction given to the foot by the construction of the ankle joint, to point the toes moderately outwards. As the leg and foot necessarily follow the rolling motions of the thigh, and more perfectly so when the leg is extended on the latter, it will be seen that the rotation of this bone inwards and outwards will imply a corresponding alteration in the position of the foot; and the great power we enjoy of turning the toes outwards, and the narrow limits to which we are confined in directing them inwards, will be found to result from the difference observed in the powers of rotation of the thigh.

The motions of the hip bone on the thigh, when the latter is the fixed point, will require no particular detail after the preceding remarks. It is sufficient to say they may be made in every direction, and with tolerable facility, particularly lateral inclination, in which one hip bone is lowered, and the opposite one elevated, and rotation; motions executed with promptness and to a great extent in the *pirouettes* of our stage dancers. We shall have occasion to speak at length of the flexion and extension of the hip bones on the thigh, when we examine the mechanism of the whole in the attitude of standing.

*The leg*—is the part of the lower extremity placed between the thigh and the foot; the bones which it contains are the tibia, the fibula, and the patella.

The tibia, the largest of the three, alone supports the weight placed on the leg from above; it comes next to the femur in size, is larger above than below, nearly triangular throughout, divided into an upper, femoral extremity, or head, a middle part or body, and a lower or tarsal extremity.

The upper extremity is nearly oval, with the long diameter transverse, large, and spreading.

The vertex or top presents two articular hollows or sinuses; of which the internal is oblong from before backwards, and deeper than the external, which is nearly circular. They correspond to the condyles of the femur by the intervention of moveable cartilages; and are divided from each other by a middle eminence, terminating in a rough depression before and behind, which completes the separation. This protuberance, placed nearest to the posterior edge of the head, is not much elevated; it slopes into the articular surfaces at the base, and is bifid at the summit, with a rough groove in the interval. The rough depression in front is larger than that behind; they both give attachment to the semi-lunar inter-articular cartilages of the knee, and to the crucial ligaments of the joint. In front of the upper extremity is a broad, flat, triangular surface, with the base upwards, corresponding to the ligament of the patella. The lateral parts have been called the tuberosities; they project considerably by a convex edge, separated in front by the flat space just mentioned, behind by a notch varying much in depth. The internal protuberance is the largest, and is marked by the attachment of the semi-membranosus behind, the external presents in the same aspect a rounded articular surface inclined downwards, for connection with the fibula.

The body of the tibia is slightly curved outwards above, and inwards below, diminishing in bulk as we trace it from the upper extremity till about one-third from its lower end, from which point its size gradually increases again downwards. It is of a prismatic form, with strongly marked edges. The anterior of these, the crista or spine, commences above at a rough eminence, called the anterior tuberosity of the tibia, into which the inferior ligament of the patella is fixed in front, and the tendons of the sartorius, gracilis, and semi-tendinosus internally; it is sharp above and in the middle, in the latter of which portions it projects a little, and becomes insensibly lost below; it forms by its course a waving line, which gives attachment to the aponeurosis enveloping the muscles of the leg. The internal edge is flattened above, and more angular below; in the first portion it gives attachment to the popliteus, for the lower two-thirds to the long flexor of the toes. To the external ridge, the least prominent of the three, the interosseous ligament is fixed; below it bifurcates and is continued into the edges of the articular cavity, which receives the lower end of the fibula. Of the surfaces between these edges, the internal or the shin is the largest; smooth, slightly convex above, and covered by the tendons of the sartorius, gracilis, and semi-tendinosus; throughout the rest of its extent it lies immediately under the skin. The outer surface is hollowed longitudinally above, and convex below, where it turns a little forward; its upper half is covered by the tibialis anticus, to which it gives attachment, and lower down the tendon of this muscle, with those of the extensor of the great toe, and the common long extensor of the toes, pass over it. The posterior surface is crossed obliquely by a line passing downwards and inwards from the articular surface, at the back of the external tuberosity; above this the popliteus is attached; below, the tibialis posticus, and long flexor of the toes; to the line itself these muscles are fixed, as also the soleus. It

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is towards the upper end of the posterior surface that we find the hole which gives passage to the nutrient vessels.

The lower extremity is much less in volume than the femoral or upper; it is nearly quadrilateral with an articular cavity of the same form at the bottom, which rests on the foot. Of the four sides, the anterior and posterior are straight, transversely and nearly parallel, giving attachment at their edges to ligamentous fibres; the latter presents also a groove for the passage of the long flexor of the great toe. The internal is prolonged downwards below the level of the others, forming a broad and strong process, called the malleolus internus. This eminence does not correspond exactly to the inner tuberosity of the femoral end, but is situated a little more forwards from the slightly twisted form of the bone. The circumference of its anterior and lowest parts gives attachment to ligaments; the posterior has a broad and superficial hollow, over which pass the tendons of the tibialis anticus, and the long flexor of the toes; the inner surface is convex, and covered by the skin, the external is smooth, presenting a vertical articular surface, joining above the large articular cavity, the depth of which it considerably increases. On the outer side of the tarsal extremity is a triangular hollow with the summit upwards, smooth below, and covered by cartilage, where it receives the fibula, rough above for the attachment of strong and short ligamentous fibres, which secure the connection: the edges of the cavity are continued above into the external spine of the body of the bone, and give attachment to ligaments which pass to the fibula. The articular surface at the bottom is a little concave, quadrilateral, narrowest and deepest towards the inner side, crossed antero-posteriorly by a broad gently rising eminence; it corresponds to the upper surface of the astragalus, the highest of the bones of the tarsus.

The structure and formation of the tibia resemble those of the other long bones. At birth the extremities are cartilaginous, and are not completely ossified and united to the body till a late period; the bony spines in the latter are already very prominent, and better marked than in any other bone. The tibia is articulated with the femur, the fibula, and astragalus.

The patella, rotula, or knee-pan (kniescheibe, Germ.) is situated in front of the knee-joint, or articulation between the femur and tibia, varying as the leg is bent or extended, in its relative position with regard to the femur. It is flattened, of a triangular form, with the base upwards, the upper angles rounded, the lower more acute. The anterior surface is convex, pierced by numerous longitudinal openings, covered by a tendinous expansion from the extensors of the leg, which is partially attached to it, and by the skin. The posterior articular surface is oblong, transversely divided by a blunt elevated line, passing rather obliquely from the upper edge to the lower angle, into two differently inclined concave faces, of which the external is the largest and deepest; they both correspond to the condyles of the femur on which they play. It is terminated below by a rough depression, into which a portion of the ligament of this bone is fixed. Of its circumference, the upper edge is thick, and gives attachment to the tendon of the extensors, the lateral borders slightly convex, to the common aponeurosis of these muscles. In the lower angle the strong anterior ligament which connects the patella to the tuber in front of the tibia is firmly implanted.

The substance of the patella is spongy in the middle, covered by a thin crust of compact bone. It is formed in the thickness of the tendon of the extensors, and always preserves the appearance of longitudinal fibres. It is not till some years after birth that bony matter is deposited in room

of the cartilaginous substance at first observable, and it is a later period still before it is fully developed. The patella is articulated with the femur, and connected with the tibia by means of a ligament, of which we shall speak below.

*The knee joint, or articulation of the femur with the tibia and patella.*—This joint, one of the most complicated in the body, results from the contact of the condyles of the thigh bone with the head of the tibia and the posterior surface of the patella. The first of these, as well as the articular pulley formed by their union in front, are covered by cartilage, which is thicker in the middle of the condyles than at their circumference; the cartilage covering the patella is particularly thick, it is thinner on the hollows of the tibia, particularly in their centres. The forms of the articular surfaces of the femur are accommodated to those of the patella and tibia; but in the latter case the correspondence is further maintained by means of two inter-articular femi-lunar fibro-cartilages, interposed between the femur and tibia in such a manner, that a small portion only of the latter bone comes into actual contact with the condyles of the former. The relations between these parts are secured by muscles, and their tendons, by the ligament of the patella, two lateral, and the same number of crucial or oblique ligaments, a posterior ligament, and by a synovial membrane spread over the whole.

The ligament of the patella, which may be regarded as the termination of the tendons of the extensor muscles, consists of a very strong flat band of fibres attached above to the lower angle of that bone, and to the depression on its posterior surface, from which points it extends about two inches in length, and half as much in breadth to the anterior tuberosity of the tibia. It is covered in front by the skin and an aponeurotic expansion. The posterior surface corresponds above to some fat and cellular tissue lying betwixt it and the synovial membrane, below to a small synovial capsule placed between it and the tibia, a smooth portion of which it covers, just above the insertion of the ligament. The edges are continuous, with an aponeurosis proceeding laterally to the tibia. It is composed of parallel, shining, tendinous fibres, of which the anterior or most superficial are continued in front of the patella to be identified with those of the immediate tendons of the extensors. It is exceedingly strong, and capable of resisting the strongest efforts of these muscles.

The internal lateral ligament is flat and thin, attached above to the internal condyle of the femur, it becomes broader as it descends, part of its fibres is inserted into the edge of the internal semi-lunar cartilage, and into the edge of the head of the tibia, the greater portion contracted in breadth is continued further down, and becomes fixed at the commencement of the body of the bone to the internal edge, where it joins the aponeurotic insertion of the popliteus. It is covered by an aponeurosis descending from the fascia lata of the thigh, and below by the tendons of the sartorius, the gracilis, and semi-tendinosus: it lies over the synovial membrane, the internal semi-lunar cartilage, and a small part of the tibia. The external lateral ligament is placed between the external condyle of the femur, and the fibula, in the form of a long, round, shining cord, covered nearly throughout by the tendons of the biceps. Immediately under it are the inferior articular vessels. It is fixed to the condyle above the attachment of the tendon of the popliteus, and rather behind it; to the fibula on the outside of its upper extremity, adhering to the outer semi-lunar cartilage in its passage. The posterior ligament is nothing but a tendinous expansion given off from the tendon of the semi-membranosus, which mounts obliquely up-

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wards and outwards behind the crucial ligaments, from which it is separated by cellular tissue and the middle articular vessels. It is attached above to the external condyle, and is confounded with the tendon of the outer head of the gastrocnemius. Independent of this band, which is very irregular in its form and size, we find other fibrous parcels crossing in different directions above it.

The crucial ligaments are more deeply seated, but may still be considered as external to the joint as they are covered only in front, and on the sides by the synovial membrane, and are really without the sac which it forms. They are strong fibrous bands crossing each other in their course, from which they derive their name. The anterior passes from the posterior and upper part of the hollow between the condyles, and from the interior side of the external condyle; obliquely downwards and forwards, narrowing as it descends, to be fixed in the rough surface, in front of the spine at the head of the tibia, behind the attachment of the internal semi-lunar cartilage, and on the inside of the external; being partially united to both. The posterior crucial ligament is attached above to the anterior part of the sinus between the condyles, and the outer-side of the internal condyle. It descends backwards and inwards, becomes broader, and divides into two pretty distinct bands, of which the largest is inserted into the depression behind the spine, the other joins the external semi-lunar cartilage. These two ligaments are separated from each other by cellular tissue, and by the same means from the posterior ligament behind; they adhere firmly to the synovial membrane, investing them on the anterior and lateral surfaces.

The semi-lunar cartilages, as they are termed, lie on the articular surfaces of the tibia, between them and the corresponding condyles, occupying only the circumference, the femur and tibia touching in the centre of each. They are thick at the convex margin, and become gradually thinner, terminating in a delicate concave edge, increasing thereby the depth of the cavities which receive the gibbous condyles of the femur. The internal is broadest behind, the external in front; the first represents a portion of an oval, of which the short diameter is transverse; the latter forms nearly a circle, corresponding, in this respect, to the figure of the two articular surfaces of the tibia. The upper surface of each cartilage is concave, accommodated to the convexity of the condyles, the lower is nearly flat. The convex margins are united to the ligaments which cross them in their course, especially to the lateral; that of the external has an oblique depression in it behind, where it is contiguous but not adherent to the tendon of the popliteus. The concave edges are free, thin, and sharp. The anterior extremity of the internal cartilage passes in front of the anterior crucial ligament, and is inserted on the outer side of the depression which gives attachment to it; the posterior is attached behind the spine, before the insertion of the posterior crucial ligament. The anterior extremity of the external semi-lunar cartilage is fastened to the depression in front of the spine, but much behind the attachment of the internal, and united in part with the anterior crucial ligament; behind it is implanted into the posterior depression, and is connected with a portion of the posterior crucial ligament. We have called these cartilages, not to depart too much from established language, though they are of a fibrous texture. They are formed of curved concentric fibres, which are particularly evident at their extremities and convex margins, less so in the middle, where they are more analogous in their appearance to cartilage. They are sometimes immediately joined by a short transverse ligament, continued from the convex borders in front. The internal appears more fixed in its

situation than the external, which has a gliding motion backwards and forwards on the tibia.

The synovial membrane, if we trace it from above, is reflected from the condyles of the femur, some way above the termination of the cartilage to the circumference of the patella. In this part it is loose, covered above by loose fat and by the cruræus, to the tendon of which it adheres most firmly, and laterally by an aponeurotic expansion, from the extensors passing from the edges of the patella to the tibia and femur. After lining the posterior surface of the patella, it passes on to the upper edge of the tibia in front, lying under the ligament of the former bone, and a large quantity of fat and cellular tissue placed underneath it, and keeping them at a considerable distance. From this part a duplicature of it passes backwards through the joint, and is attached to the anterior and external part of the sinus between the condyles. It has been called the ligamentum alare by Weitbrecht, or *l. mucosum*, seu *adipolum*; all names equally unapplicable to it. Laterally, also, it descends towards the tibia, investing the upper surfaces, and concave edge, and the under surfaces of the semi-lunar cartilages; after which it is continued downwards, covers the articular cartilages at the head of the bone, and is reflected upwards over the crucial ligaments in the middle, lying behind the tendons of the gastrocnemius on their anterior surface, and enveloping the tendon of the popliteus. It thus reaches the condyles behind, to the edges of which it is attached, leaving the sinus between them without the bag, and passes over the cartilages to the point from which we set out. It is covered in front by the extensors and their tendon; by their aponeurosis laterally, as also on the inside by the tendons of the  *Sartorius*, *gracilis*, and *semi-tendinosus*, and by the internal lateral ligament with which it is in contact; on the outside by the tendon of the biceps and the external lateral ligament, behind by the semi-membranosus and its lateral tendon, by the gastrocnemius and popliteus. After all, we should have a very imperfect idea of the knee joint, if we considered it in this abstract state. It is most strongly supported by the muscular powers attached to the tendons we have mentioned, the latter being numerous, and of great strength, and the muscles massy and exceedingly powerful, securing most effectually, when in action, the relations of the opposite bones.

*The motions of the leg on the thigh*—are those of flexion, extension, and under particular circumstances of rotation. In flexion, the tibia and semi-lunar cartilages glide backwards on the condyles of the femur; the patella quits the articular pulley, and descends in front of the joint, so as to be opposite to the sinus between the condyles: the tendon of the extensors occupies its place, and is much distended if the flexion be carried far back, as is also the ligament of the patella; and the crucial and oblique ligaments, as well as the posterior, are relaxed. In extension, the tibia glides forwards again, and the semi-lunar cartilages are brought opposite to the inferior instead of the posterior surfaces of the condyles, which, in this position, rest against the heads of the gastrocnemius; the patella mounts again, and, in complete extension, if the muscles are in action, passes up a little way above the articular pulley; if the muscles are quiescent, the tendon of the patella is relaxed; this bone is loose and may be moved in all directions; the posterior crucial and lateral ligaments are stretched, and prevent this motion from being carried beyond the point which brings the femur and tibia in the same line. The great strength of the crucial ligaments, which are essentially distended at this time, is a powerful obstacle to the luxation, which would throw the head of the tibia backward. When the leg is near the middle state,  
between

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between complete flexion and extension, it can be rotated slightly inwards and outwards; a motion, of which the foot necessarily partakes, and which carries the toes in corresponding directions. In rotation the articular surfaces of the tibia glide in opposite curves in the rounded surfaces of the condyles; not, however, in equal degrees, the most evident motion occurring on the outer condyle. In rotation inwards the posterior crucial ligament is brought to cross the anterior more directly, and is much tightened, so as effectually to limit it. In rotation outwards, which, on account of the disposition of these ligaments, is more extensive, we find them scarcely affected. In both cases the lateral ligaments are rendered tense; the semi-lunar cartilages undergo little change of position, excepting that in rotation inwards, the external one, from its connection with the posterior crucial ligament, is drawn a little aside. When the leg is bent, the motions by which the toes are carried alternately inwards or outwards take place in the knee joint; when it is extended, they are effected in the hip, and depend on the rotation of the femur. The patella favours extension, by removing the power further from the centre of motion, besides which it glides more readily over the pulley of the femur, than a flexible tendon could have done, and protects materially the front of the joint in flexion, for instance in kneeling. It scarcely moves in rotation inwards or outwards.

*The fibula*—is placed on the external side of the leg, obliquely with regard to the tibia, being behind it above, and immediately on the outside below. It is a slender bone, nearly equal in length to the tibia, but very much smaller, divided into an upper or tibial, or lower or tarsal extremity, and a middle portion or body.

The upper extremity is very irregular; we remark in it above, and a little on the inside, an oblique, slightly hollowed, articular surface, corresponding to one on the outer tuberosity of the head of the tibia. In every other aspect the surface is rough and unequal, giving attachment to ligaments which connect it with the tibia, to the external lateral ligament of the knee, and to the tendon of the biceps.

The body of the fibula is of an irregular prismatic figure, somewhat twisted, and curved a little, so as to approach nearer the tibia in the middle of the three angles, the anterior rises gradually from above, is sharp and prominent in the middle, and bifurcates below, where it is covered only by the skin. It gives origin, in the greatest part of its extent, to an aponeurosis, which separates the peronei muscles from the extensor communis of the toes. The external edge is spiral in its course, running backwards as it descends. It gives attachment to an aponeurosis, which divides the peronei from the long flexor of the great toe and the soleus. The internal edge becomes anterior as it descends; it is very prominent in the middle, and gradually lost above and below. The upper two-thirds give origin to the flexor of the great toe, and the tibialis posticus, the lower third to the interosseous ligament. Of the surfaces between these borders, the external alters its aspect, becoming posterior below; it is covered by the peronei, which are fixed to the two upper thirds. The internal surface looks rather backwards above, and forwards below; it is divided into two unequal portions by a spine extending from the upper part of the anterior angle to the lower part of the internal angle, and which gives attachment to the interosseous ligament. Of these two planes the anterior is covered by, and gives origin to, the extensors of the great and of the other toes, and to the peroneus tertius; the posterior, which is hollowed longitudinally, to the tibialis posticus. The direction of this

spine varies very considerably, as also its length. The posterior face is inclined outwards above, where the soleus has its attachment; below it turns inwards, giving attachment by nearly its lower two-thirds to the long flexor of the great toe. About the middle is the opening for the nutrient artery directed longitudinally downwards. It widens towards the lower extremity, where it terminates in a rough convex surface, connected with the tibia.

The lower or tarsal end of the fibula is oblong, flattened transversely, thicker behind than in front; it forms the outer malleolus, which descends rather lower, and is more pointed than the inner. The external surface is convex, and covered only by skin; the internal presents, at its anterior part, a smooth articular surface convex from above downwards, articulated with the external side of the astragalus, and behind this a rough depression for ligamentous attachments. The posterior border has in it a superficial groove for the passage of the peronei; the anterior, as well as the angle below, give attachment to ligaments.

The fibula is in structure like the other long bones. It is formed from three points of ossification, one for the body and one for each extremity. The latter are still cartilaginous at birth.

*The articulation between the tibia and fibula*—is by actual contact at the two extremities, and by means of an interosseous ligament in the intervening space. The superior articulation results from the contact of two flat cartilaginous surfaces, secured by ligaments in front and behind, and covered by synovial membrane. The anterior ligament passes from the fore part of the upper end of the fibula to the anterior part of the external tuberosity of the tibia. The fibres are transverse, the superior ones the longest, and divided into several parcels, with intervening cellular tissue. It is strengthened by a portion of the tendon of the biceps, which embraces the external lateral ligament of the knee, and passes over this anterior ligament before it is fixed to the tibia. The posterior ligament is also transverse, but not so strong, or so well marked as the preceding; it is continued above with some ligamentous fibres found in the back of the knee-joint; it is covered by the popliteus. Besides these two ligaments, we find a few other scattered bands below, which help to secure the articulation. The synovial membrane lines these ligaments, and the cartilaginous surfaces; it is separated from the tendon of the biceps by cellular tissue, and is contiguous behind to the synovial membrane of the knee. The middle connection is preserved by means of an interosseous ligament, analogous to the one we have described in the forearm. It is thin, composed of parallel fibres descending obliquely from the external edge of the tibia to the ridge dividing the internal surface of the fibula, and below to the internal edge of this bone. It is broadest at the upper part, and terminates in a point beneath, where the bones begin to touch each other. It is pierced by many openings for the passage of vessels; of these the most remarkable are, one above, near the edge of the fibula, for the passage of the anterior tibial vessels; and another below for a branch from the peroneal artery. The anterior surface serves for attachment to the tibialis anticus, the extensors of the great and other toes, and to the peroneus tertius, and supports the anterior tibial vessels. To the posterior surface the tibialis posticus and long flexor of the great toe are fixed. The inferior articulation is composed of the contact of two cartilaginous surfaces below, a convex for the fibula, and a corresponding concave one for the tibia, lined by a continuation of the synovial membrane from the ankle joint. The relations are secured by ligaments before, behind, and between

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tween the bones. The anterior ligament is broad, attached to the anterior edge of the tarsal end of the fibula; in crossing to the tibia it mounts a little upwards, widening in its progress, its fibres divided by intervals filled with cellular tissue, the superior the longest, and is fixed to the neighbouring parts of the tibia. It is covered by the peroneus tertius, aponeurosis of the leg and the shin; its lower end is confounded with ligamentous fibres passing from the fibula to the astragalus. The posterior ligament resembles it in direction, but it is not so large, and the lowermost fibres are the longest. It passes immediately from the posterior part of this end of the fibula to be fixed to the tibia behind the cavity which lodges that bone, is confounded with the surrounding ligaments below, covered behind by the two lateral peronei muscles. In addition to these ligaments we observe, between the opposite surfaces of the two bones, just above their cartilaginous contact, a fibrous substance passing from one to the other, occupying a considerable space, interrupted here and there by cellular tissue, and continuous above with the interosseous ligament. It materially secures the articulation.

The motions of the fibula on the tibia are excessively limited, very different in this respect from those between the bones of the fore-arm. The upper end of the fibula may glide a little backwards and forwards; the lower is nearly motionless from the disposition of the ligaments, a structure necessary for the stability of the articulation of the leg with the foot, as resisting the tendency to lateral displacement.

*The foot*—forms the last division of the lower extremity; it has some characters in common with the hand, but is distinguished from it in a remarkable manner by its great depth and firmness, by the preponderance of its solid over its moveable parts, the reverse of which is so strikingly seen in the hand. It varies much in size, in general is proportionally smaller in the female than in the male, is elongated in form, broad and flat anteriorly, thick and narrower behind. It is convex on the upper surface, which is called the back of the foot, concave on the lower, called the sole, thin on the outer edge, deeper and longer internally, with a projection behind, named the heel, and terminated by the points of the toes in front. We divide it, as we did the hand, into three portions; the tarsus behind, the metatarsus in the middle, and the toes before.

The tarsus (oberfuss, Germ.) forms about the posterior half of the foot; it is composed of seven bones, viz. the astragalus, the os calcis, naviculare, cuboides, and three cuneiform bones.

The astragalus, (talus of Albinus,) occupies the upper part of the tarsus, rising far above the level of the other bones; it is of a very irregular form, convex above, hollowed below, flattened at the sides, and running out into a strong process before, termed the cervix or neck of the bone. It is placed fast between the two bones of the leg, the heel bone, and the os naviculare. On the upper surface, anteriorly, is a rough, transverse depression, forming part of what has been called the neck of the bone, for insertion of ligaments; behind this is a large articular surface, broader before than behind, convex in those directions, rather concave from side to side, so as to form a superficial pulley, suited to the opposite surface of the tibia. Below we have two articular surfaces, which rest on the os calcis, separated by a deep groove, running obliquely from within outwards, widening much in its course, and rough for ligamentous attachments. The posterior articular surface, which is external, is the largest, concave, and oblong obliquely; the anterior is small, oval, and nearly flat. The

posterior side is narrowed horizontally, and presents the commencement of an oblique groove, in which the tendon of the long flexor of the great toe glides. In front is a convex rounded articular surface, which has been called the head of the bone; it rests against the os naviculare, and by a small surface on the os calcis. On the outside a triangular articular surface, concave vertically, corresponding to the lower end of the fibula. On the inside another articular surface, flat, elongated horizontally, adapted to the descending malleolus internus; below this a rough irregular surface for ligaments. These two articular surfaces are continuous with that on the upper surface, and form part of the ankle joint. It is developed from two points of ossification, which are just appearing at birth.

The os calcis (calcaneus of Albinus,) is situated at the posterior part of the tarsus, where it forms the heel. It is the largest of the seven bones; its greatest extent is from behind forwards, its next is in the depth, and it is narrowest transversely. On the superior surface we observe posteriorly a concave part occupied by the fat and cellular tissue in front of the tendo Achillis; next we have a large, convex, oblique articular face, adapted to one in the astragalus; on the inside of this a groove, which divides it from another smaller oval, flat, articular facet, corresponding also to the astragalus. This last is placed on a lateral process of the bone, ("sulentaculum cervicis tali, Alb.") and is rather anterior to the first. It is sometimes continuous with another small articular surface in front of it, though generally separated by a narrow groove. The rest of the upper surface is flat and rough for ligaments. The under surface is long, much contracted transversely, terminated behind by two tubercles which give attachment to some muscles of the toes; the internal is the largest. There are also other eminences further in front to which ligaments are fixed. The posterior surface is bulging and convex, and forms properly the heel; at the upper part it is smooth, where it is separated from the tendo Achillis by a synovial bursa, and rough below for its insertion. The anterior surface is the smallest of the whole; it is articulated with the os cuboides, and is slightly concave. The outside is flat, much broader behind than before, and marked by two superficial grooves for the long and short peronei muscles. The inside is large and hollowed deeply, to lodge the nerves and vessels going to the sole of the foot, and also the tendons of the tibialis posterior, the long extensor of the toes, and the long extensor of the great toe, which plays in a peculiar groove observed at its upper part. The musculus accessorius has its origin from this surface, towards the back part. The os calcis is formed from two points of ossification, which are visible at birth. The two bones we have been describing have been considered as the first row of tarsal bones; the remaining five as the second.

The os naviculare is situated in the middle of the tarsus, of an oval figure, with its longest diameter transverse; its circumference is rough for ligamentous attachments; broad and convex above, concave below, pointed and projecting internally where the tibialis posterior is inserted, and narrowed on the outer side, on which we generally find a flat articular facet opposed to the cuboides. The anterior surface is convex, divided into three articular planes for the three cuneiform bones; of these the internal is broadest below, and the two external above. The posterior surface is concave, articulated with the astragalus.

The os cuboides, (cubiforme, Alb.) is placed at the external and anterior part of the tarsus, and resembles somewhat a cube in figure. Above is a rough, slightly convex surface, with four unequal sides; below posteriorly an emi-

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nence for ligaments, a superficial hollow, and a more marked protuberance for the same purpose, in front of which is a deep groove, which gives passage to the tendon of the peroneus longus, as it crosses the foot. Anteriorly an oblique articular surface nearly plane, supporting the two outer metatarsal bones. Behind a concave smooth surface, still more oblique, articulated with the os calcis. Externally, a narrow border, in which we observe the commencement of the groove for the tendon of the peroneus longus. Internally, a small articular facet behind, in contact with the os naviculare; a larger one in the middle for the third cuneiform bone; the rest of the surface is rough for ligaments.

The first cuneiform bone (*majus five internum*) lies at the inner and anterior part of the tarsus, and is the largest of the three; it is deeper than it is broad, with the base of the wedge below, and the narrower border upwards, of a rhomboid figure viewed laterally. The upper side is oblique, and gives attachment to ligaments; the inferior is convex, and gives attachment before to the *tibialis anticus*, behind to a part of the *tibialis posticus*, as well as to ligaments. The posterior surface, articulated with the naviculare, is concave and pointed above; the anterior, by which it rests on the first metatarsal bone, is longer, and of an oblong, or rather semi-lunar figure. Internally, it is convex, rough, and sub-cutaneous; externally concave, with a small articular facet near the upper edge, in contact with the second bone of the metatarsus, and another near the posterior edge, which touches the following bone.

The second cuneiform bone (*minus five medium*) is the smallest of the three, and of all the bones of the tarsus; it well deserves its name both from its figure and situation. The base of the wedge forms the upper surface which is quadrilateral, with the short diameter transverse, and rough for ligaments. The edge of the wedge below is sharp, and serves the same purposes; behind it is articulated by a concave surface, with the middle plane in the front of the os naviculare; before, by a convex one, with the second metatarsal bone. Of the two four-cornered sides the internal is nearly plane, with an articular facet near the upper edge, and another at the posterior, joined to the last bone; the external has a concave articular facet for connection with the third cuneiform bone towards the upper and posterior angle: they are both rough on the remainder of their surfaces for fibrous attachments.

The third cuneiform bone (*externum, or medium, Alb.*) is rather larger than the preceding, and longer from before backwards; it resembles it much in figure and position. The base, which is above, and the edge below, give attachment to ligaments. Behind is a triangular articular surface, corresponding to one of the planes in front of the naviculare; before an oblong flat one in contact with the third metatarsal bone. The internal surface is marked by two articular facets, separated by a rough depression for ligaments, of which the anterior corresponds to the second metatarsal bone, the posterior to the second cuneiform. The external side is rough anteriorly, and has a plane articular facet towards the upper and posterior angle, in contact with a corresponding one on the inner side of the *euroides*.

The last five bones of the tarsus are wholly cartilaginous at birth, and are gradually and solely developed from single points of ossification. They are not proportionably larger in this state than when in their perfect osseous forms, in which respect they resemble the carpus.

*The articulation of the leg with the foot, the ankle joint.*—To form this joint, the upper articular surface of the *atragalus*,

nearly all the outer side, and the narrow cartilaginous facet on the inside, are received into the cavity formed by the lower end of the tibia and fibula, and embraced closely by the two ankles. The corresponding surfaces are covered by cartilage, and united by several ligaments, the most efficient of which are placed at the sides; the connection is much strengthened by the numerous tendons which pass over or near it to be attached to different bones of the foot.

The internal ligament (*l. deltoides*) is of considerable breadth; attached above to a part of the circumference of the internal malleolus, more especially to its point, it descends a little obliquely backwards, and is fixed to the inner surface of the *atragalus*, and the neighbouring parts of the os calcis. It is composed of a considerable quantity of longitudinal fibres, of which the anterior and the most superficial are the longest. On the inside, the tendon of the *tibialis posticus* passes over it, and is connected with it by its fibrous sheath; it is contiguous also to the long flexor of the toes. On the outside is a straight rounded and thick ligament (*l. medium perpendiculare*) which descends from the lower extremity of the fibula a little obliquely backwards, passing under the tendon of the peroneus longus, and is attached to the outer side of the os calcis; it is formed of compact, longitudinal fibres. In front of this is another ligament (*l. anterior malleoli externi*), which passes from the anterior part of the point of the outer malleolus, forming a strong flat band of fibres, frequently divided into two or more portions of considerable strength, and is fixed to the *atragalus* in a depression before the external articular surface. The front of the joint is strengthened also by a collection of irregular fibrous bands, which descend from the anterior part of the lower extremity of the tibia, amidst much cellular tissue and fat, and are inserted partly into the *atragalus* close to the termination of the articular pulley, and are partly continuous with the ligaments passing from this bone to the naviculare. Towards the back of the joint, we have arising from the fibula a strong ligament (*l. posterius malleoli externi*) passing nearly transversely inwards, and fixed to the edge of the articular pulley at the back of the *atragalus*, close to the outer margin of the groove for the tendon of the long flexor of the great toe. It is stronger than any of the preceding ligaments, and composed of numerous distinct packets of fibres. Immediately above this, and connected intimately with it, at its origin from the back of the external malleolus, is a transverse band of fibres passing directly across, or mounting a little obliquely, to be attached to the posterior border of the articular surface of the tibia, and to the inner ankle. It increases a little the depth of the articular cavity behind, and might be regarded properly as one of the posterior ligaments connecting the tibia and fibula. The synovial membrane is distributed as usual, lining all the cartilaginous surfaces and the ligaments; lining also the narrow articular facets between the tibia and fibula, making this little joint communicate with that between these bones and the *atragalus*. It is loose in front, where we find a considerable quantity of cellular tissue and fat; covered in this aspect by the tendons of the *tibialis anticus*, the long extensors of the great, and other toes, and the peroneus tertius; behind by the tendons of the *tibialis posticus*, the flexors of the toes, and the peronei; partly in these situations, and on the sides by the ligaments just described. In addition to the many tendons enumerated, this articulation is further strengthened by the tendo Achillis behind, a powerful agent in preserving its relations.

The motions which take place between the leg and foot are chiefly those of flexion and extension; the lateral in-

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flexions are extremely limited. In flexion, which is more confined than the opposite motion, on account of the disposition of the articular pulley of the astragalus, this bone glides backwards on the lower end of the tibia, regulated by the two malleoli lying close on either side; the posterior ligament is stretched, the others undergo but little change; and luxation rarely occurs. In extension the motion may be continued, so as to make the foot form a very obtuse angle with the leg; the external anterior ligament is distended considerably, the others less so, the posterior is relaxed. In standing on the toes this position is maintained by muscular efforts, particularly by means of the tendo Achillis; the tibia rests on the posterior part of the pulley of the astragalus, and transmits the principal weight to the naviculare, instead of the os calcis, as in ordinary station. The lateral inclinations of the foot on the leg, as far as this joint only is concerned, are extremely confined, owing to the lateral descent of the malleoli; in which respect they differ much from the lateral motions of the carpus on the fore-arm. The lateral ligaments are here reciprocally stretched or relaxed, as the foot is turned inwards or outwards. Dislocations to either side occur more frequently than we might at first imagine from the apparent security afforded by the malleoli. Luxation outwards is the most frequent, the fibula breaking two or three inches above its lower end, so as to allow of the eversion of the foot; it is generally the consequence of sudden violence, as in jumping, or in falling on the foot from any height.

*The articulations between the bones of the tarsus.*—The astragalus is articulated by two, sometimes three cartilaginous planes on its inferior surface, with corresponding ones on the upper surface of the os calcis. These surfaces are preserved in contact by a strong collection of ligamentous fibres, passing directly upwards from the whole length of the oblique groove, between the articular facets on the upper surface of the os calcis to a similar depression on the under side of the astragalus, where it is attached to every point not occupied by articulating cartilage. The internal fibres lie deep between the bones, and are short; the external ones are longer, and more in quantity, buried in the cellular tissue and fat which contribute to fill the vacancy observed in this part. Behind there are some parallel fibres passing down from the back of the astragalus to the os calcis, which concur in forming the sheath for the tendon of the long flexor of the great toe; they are not numerous. This articulation is also strengthened by the lateral ligaments of the ankle joint, especially by the external, which passes immediately from the fibula to the os calcis. The synovial membranes offer nothing remarkable. The motions which have place here are always combined with others, and will be considered farther on.

The anterior convex articular surface of the astragalus is received into a cavity formed by the concave surface of the os naviculare, a small spot of the os calcis, and completed below by ligaments passing between these two bones. We observe above a dorsal ligament, thin and flat, composed of fibres passing from the depression called the neck of the astragalus to the upper rough surface of the naviculare; they sometimes reach to the cuneiform bones. It is covered by the extensors of the toes. Below is a very strong ligament, passing from the anterior and internal parts of the os calcis obliquely forwards and inwards to be attached to the hollow in the lower surface of the naviculare. It is covered on the inside by the tendon of the tibialis posticus: above it is lined by synovial membrane, and forms the lower part of the cavity which lodges the head of the astragalus, the support of which it eminently contributes. It is very dense in its structure. There is also a short and very firm

band passing from the anterior part of the os calcis to the outside of the naviculare, completing the cavity externally. This joint is lined by a synovial membrane, which communicates with the anterior articulation between the astragalus and os calcis, as before mentioned. It is spread over the corresponding surfaces and ligaments we have been describing.

From what we have said, it appears that the os calcis is firmly connected with the naviculare, though in contact only by a very narrow spot; the ligaments cross the head of the astragalus in their course, and their apparent use is to support the latter, at a point which appears so deficient, when examining the mechanism in the dry skeleton. The os calcis is more extensively articulated with the cuboides by cartilaginous surfaces slightly concave and convex in opposite senses. The joint is secured by two ligaments, a superior or dorsal, an inferior or plantar. The first is broad and thin, composed of short parallel fibres passing rather obliquely forwards from the upper and external parts of the os calcis, to the superior rough surface of the cuboides. It is often formed into two separate longitudinal bands. It lies under the peroneus tertius. The inferior ligament is the longest, and strongest of all the ligaments of the tarsus. It is attached behind to the middle of the inferior surface of the calcis, passes horizontally forwards, and is fixed principally into the oblique protuberance observed on the lower surface of the cuboides. It is formed of a great number of fibres, divided into several bundles, which diverge rather as they approach the cuboides. The inferior ones, or the most superficial, are much longer than those more deeply seated, and are continued under the tendon of the peroneus longus, part of whose sheath they form, to the posterior extremities of the first and second metatarsal bones. The upper plane is shorter in its course, and fixed behind the groove for the peroneus longus. The ligament is covered below by several muscles of the foot, which have partly their origin from it. It should be remembered that this joint is in the same transverse line with the one between the astragalus and naviculare.

For the articulation between the naviculare and cuneiform bones we have in the first a cartilaginous surface divided into three planes, in the latter corresponding surfaces covered by articular cartilages continued laterally into their mutual articulations. It is secured by three dorsal ligaments, attached to the upper and lateral portions of the circumference of the naviculare, passing one internally to the first cuneiform, another in the middle to the second, and a third more externally to the outer cuneiform bone. They leave intervals filled by cellular tissue: the internal is the largest; and thicker at its inferior edge. The plantar ligaments have been described as three also, but they are too irregular for distinction, appearing as fibrous bundles passing between the opposite bones, confounded at their attachment to the naviculare. This joint is strengthened internally by an elongation of the tendon of the tibialis posticus, which is attached to the base of the first cuneiform bone, and continuous with the more internal of the ligaments we have been describing.

The articulation of the naviculare with the cuboides is formed by the contact of two small plane cartilaginous surfaces, lined by their proper synovial membrane, and secured by numerous short ligamentous fibres passing from bone to bone, occupying the remaining space; they are very close and compact. There is also a plantar ligament rounded in form, passing obliquely from the inferior and external part of the naviculare to the opposite point of the cuboides; and a dorsal transverse band, crossing from one to the other, covered by the extensors.

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The cuneiform bones are articulated with each other by cartilaginous facets connected by ligaments passing from bone to bone, deeply as well as superficially. The dorsal ligaments are transverse, and form really but a single band, continued over the three, and attached in its course to each. The plantar ligaments are also transverse, but not so marked; the one which goes from the first to the second is the strongest: they are covered by an extension of the tendon of the tibialis posticus, one part of which is fixed to the second cuneiform, another to the second metatarsal bone; these are distinguished from the ligaments by the opposite direction of their fibres. We find also many short ligamentous fibres passing between these bones, as between many others of the tarsus, attached to the parts not occupied by cartilage: they add much to the strength of union.

We have here a synovial membrane common to these joints, and that with the os naviculare above described. It is spread over the anterior surface of the latter, over the connecting ligaments, and dips between the cuneiform bones, lining their articulation throughout.

The articulation of the third cuneiform with the cuboides is by means of plane cartilaginous surfaces, provided with their distinct synovial capsule, and secured by ligaments. Of these the dorsal is oblique, small and thin, uniting the opposite edges of bone; the plantar is considerably thicker, and more directly transverse. Here also are many interosseous ligamentous fibres, fixed to the parts not covered by cartilage, or where the bones are not in immediate contact.

*Motions of the tarsal bones on each other.*—The motions which take place between the tarsal bones are very limited, if we except those between the astragalus, and the os calcis and scaphoides. By this chiefly the foot is turned inwards and outwards; the lateral inflexions of the ankle joint assisting the motion but little. In the movement which carries the point of the foot a little outwards, which depresses its internal and elevates its external edge, the naviculare glides on the head of the astragalus, and the os calcis on its lower articulating surfaces: the latter bones approach each other more closely, the interosseous ligament, and the external lateral one of the ankle joint are relaxed, the internal lateral ligament is stretched, especially those fibres which pass to the calcaneum. In the opposite motion of twisting the foot inwards, and bringing the sole to face the other, the bones move in the contrary direction, the inner border of the foot is raised, and the external becomes inferior; the interosseous, and external lateral ligaments are distended. These motions, which are very sensible, may be accidentally forced beyond their natural limits, and give rise to injuries which are too generally referred to the joint of the ankle. The naviculare and cuboides may be moved up and down on the astragalus and os calcis, and the cuneiform bones have gliding motions on the naviculare, the cuboides, and between themselves, by which the concavity of the foot may be a little increased or diminished. The utility of these numerous articulations in enabling the foot to resist the shocks it must often necessarily suffer, and in giving grace and ease to the motions of the lower extremity in progression needs scarcely be insisted on: their great relative size and the very powerful ligaments subservient to them make displacement of more rare occurrence than we might at first imagine, on considering the efforts they have to sustain.

*The metatarsus* (mittelfuss, Germ.)—is composed of five long bones placed horizontally and nearly parallel to each other, so as to form a gently convex surface above, and a concavity below. It is situated between the tarsus and the toes, and is analogous in many points to the metacarpus.

The individual bones are distinguished numerically, beginning from the inside. The first metatarsal bone, that of the great toe, is by much the largest in volume, though rather shorter than the rest; the second is of the greatest length; the third comes next to it, the two last differ but little; the four latter differ very little in size. They all contract a little in the middle, and swell at each end, particularly towards the tarsus, and are divided into two extremities and a body.

The tarsal, or posterior extremity of the first, is oblong vertically, with a semi-circular articular cavity behind, resting on the first cuneiform bone. The inner edge of the circumference, which is convex, gives attachment about its middle to a part of the tendon of the tibialis anticus; below is a blunt projecting process, to which the tendon of the peroneus longus is fixed; and on the outer concave edge a small smooth spot, which is in contact with the second metatarsal bone.

The tarsal are much larger than the digital extremities of the other four, angular, and in close opposition with each other. That of the second is placed farther back than the first, is triangular, with the base upwards; it is wedged between the cuneiform bones, resting on the second by a concave triangular articular surface behind; on the first by a small spot on the inside, and on the third by one on its outer side. In the last aspect there are two other articular facets in front of the last joined to the third metatarsal bone, surrounded by asperities for ligaments: the edge above, and the point below are also rough, for the same purposes. The tarsal end of the third is triangular in the same direction as the preceding, articulated by a plane surface behind, with the third cuneiform bone. On the inside are two small facets contiguous to corresponding ones in the second metatarsal; on the outside a smooth spot above, articulated with the following bone, and a rough depression beneath for ligaments. It is rough also above and below. In the fourth, the tarsal extremity is more quadrilateral: behind it is articulated with the front of the cuboides; on the inside with the same bone, and with the third; on the outside with the last metatarsal. Below, and in front of these articular spots, the bone is rough for ligamentous attachments. The tarsal end of the fifth or last metatarsal bone is larger than those of the preceding. It presents behind an oblique triangular articular surface for the cuboides; above and below rough and unequal borders, the former giving attachment to the peroneus tertius, and both to ligaments; on the inside a small articular facet in contact with the fourth; and on the outside a rough eminence projecting backwards, to which the peroneus brevis is fixed, and a portion of the abductor of the little toe.

The bodies of the metatarsal bones are concave from before backwards below, and gibbous above, very irregular in form, and scarcely admitting of regular divisions into surfaces. That of the first is of a triangular prismatic form, with the upper surface convex, and inclined a little inwards; the inferior concave, covered by the flexor brevis of the great toe; the external flat and large, corresponding to the muscles which lie between these bones. The bodies of the rest may be regarded in four aspects; the dorsal presents in each a blunt rising line, which divides the attachment of the interossei; the plantar offers a smooth surface for muscular attachments; the internal and external exhibit variously inclined surfaces, of different breadths, continuous with the two former, smooth, and covered by the muscles which arise from them, and fill the interspaces. In the fifth the body is curved a little from within outwards, and its external side, or rather edge, gives origin in part to the

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the abductor of the little toe; the dorsal surface is inclined considerably outwards, and terminates on the inside by a prominent line; the plantar surface is covered partly by the flexor brevis of the same toe. In all the dorsal surface is covered by the tendons of the long and short extensors, by vessels and nerves, and the plantar by the deep-seated muscles and tendons in the sole of the foot, by ligaments, and by larger blood vessels and nerves.

The digital, or anterior extremity, is very similar in all. It presents a rounded articular surface, called the head, supporting the first phalanx of the toes: this extends further from above below than transversely, in which direction it is compressed. The circumference is rough, offering above a sensible groove for ligaments, and on each side a hollow, in which the lateral ligaments are fixed. The articular surface is prolonged further below than on the dorsal aspect, and terminates on each side by projecting tubercles. In the first this lower surface is divided by a prominent line into two pulleys, on which the sesamoid bones glide, which are placed below this joint of the great toe. In this bone also the articular surface has a much greater proportional breadth.

The metatarsal bones resemble in structure and formation the other long bones, with this exception only, that the smaller ones are sometimes developed from two points of ossification, one for the tarsal extremity, and body, another for the digital: in the first there are always three.

*The articulations of the metatarsus with the tarsus.*—The first bone of the metatarsus is articulated with the anterior surface of the first cuneiform; the second with the three cuneiform bones; the third with the corresponding cuneiform; the fourth and fifth with the cuboides. The opposite articular surfaces are covered by thin cartilage, and their relations preserved by ligaments above and below; they are all lined by synovial membranes common in general to these joints, and to the articulations of the metatarsal bones between themselves.

The dorsal ligaments pass from each metatarsal bone to those bones of the tarsus with which they are articulated. From the first there passes a broad and thin band to the first cuneiform, attached to the superior surface of each. From the second, which is let in between the three cuneiform bones, we find three ligaments crossing, one internally to the first, another in the middle to the second, a third externally to the third cuneiform: the first and last are oblique in their course, the second passes directly from before backwards. The dorsal ligament of the third is short, and goes straight to the third cuneiform; those of the third and fourth are attached to the upper surface of the cuboides; they are more or less oblique, and by no means constant in their forms or situation, the dorsal ligament of the fourth being often attached to the third cuneiform. They are all covered by the extensor tendons.

Of the plantar ligaments, which are analogous in direction and attachment to the dorsal, that passing from the first metatarsal is very strong, and the joint is strengthened also by an extension of the tendon of the tibialis anticus, which is fixed to the inside of the tarsal end of that bone. The plantar ligaments of the second are similar to those above. That which passes from the first cuneiform is thicker, and larger than the other, reaching to the base of the third metatarsal; the other two are covered and strengthened by a portion from the tendon of the tibialis posticus. The inferior ligaments of the others are small, yet distinct, and of various lengths. The plantar ligaments are much strengthened by the numerous tendinous sheaths which are found in the sole of the foot, and particularly by that of the peroneus longus,

which crosses most of them as it passes along to reach the first metatarsal bone. The ligaments, both above and below, are composed of short and close parallel fibres, following longitudinal, oblique, or transverse directions, according to the relations between the points to which they are fixed. They are separated by intervals filled with cellular tissue, and giving passage to vessels. The synovial membrane, lining the joint between the first metatarsal and cuneiform bones, is distinct, and offers nothing remarkable in its distribution. That lining the triple articulation, formed by the second with the three cuneiform bones, is continuous with the synovial membrane, lining the articulation between the two first of these bones. A separate one is found spread over the joint of the third metatarsal and cuneiform, and sending off two small lateral elongations, which dip between the articulations of the third with the second, and fourth metatarsals. It often communicates with the former at the point where they are in contact. Another synovial membrane belongs to the articulation of the two last metatarsals with the cuboides, common also to that between the two former of these bones.

*The articulations between the metatarsal bones,*—are formed behind by the contact of lateral articular facets, with the exception only of the first, which touches the second without being articulated with it. These two bones are united by short ligamentous fibres passing from one to the other, of considerable strength; the others are connected by dorsal, plantar, and interosseous ligaments. The dorsal are transverse, and three in number, passing from one bone to the next, irregular in form, and attachment, appearing in some subjects as a single transverse band. The plantar are similar in number and direction, but in addition we find several small slips passing from the fifth to the three next metatarsals, separated by cellular tissue. The interosseous ligaments between the posterior ends of these bones are formed by numerous short fibres, occupying the parts not covered by cartilage, and tending very materially to secure their relations. The anterior extremities of the metatarsal bones are not in absolute contact, but they are firmly connected together by a transverse ligament passing below them, and attached to each bone, resembling the ligament described as passing between the digital ends of the metacarpal bones in its form and direction.

The metatarsal bones have but an obscure motion on the tarsus, on which they may be slightly elevated and depressed. They may be moved also so as to approach each other in front, and augment the depth of the concavity of the sole; this effect is produced chiefly by the motion of the first and last towards the long axis of the foot, and is in consequence of muscular action: when the foot is flattened by pressure they are forced farther apart mechanically.

The toes, forming the last division of the foot, are five in number, placed horizontally side by side, composed of rows of small bones extending longitudinally one beyond another. We reckon them numerically, beginning from within. The first and last are known also by the names of the great and little toe. The second is rather longer than the first, the other three diminish successively in length. We find three bones, named phalanges, in all, excepting the first, which has only two; these are termed, from their situation, the first or metatarsal phalanx, the second or middle, and the third or ungual; in the great toe the bone of the middle phalanx is deficient. The two bones of this last are very strong, and exceed very much in volume the different rows of the other toes which are slender in form, and comparatively weak. The bones of the first phalanx are the longest; those of the second are very short, as also the third. They

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all swell considerably at the extremities, and are contracted in the middle part or body. They resemble the fingers very nearly in the material points of their formation, differing from them chiefly in size and mobility.

The first phalanges are by much the longest, and the bones are more rounded than the corresponding ones in the fingers. They are hollowed below, particularly near the extremities, where the flexor tendons lie, the edges giving attachment to the sheaths which confine them. The posterior extremities are concave for the heads of the metatarsal bones, the anterior have condyles, and a middle depression for the second phalanx. The two opposite articulating surfaces between these bones and the corresponding ones of the metatarsus, are crufted by cartilage, and secured by lateral ligaments, as in the fingers. These are thick and strong, passing from the end of one bone to the opposite. The joint is strengthened below by a transverse ligament, covering it from side to side, contributing to the sheath of the flexor tendons; and is further supported by these last, by the extensors, and the smaller muscles which surround them. The synovial membrane is loose and extensive; in the joint of the great toe it lines the two sesamoid bones. These small bones are unequal in size; the internal is the largest, oblong, gibbous below, concave longitudinally above, and a little convex transversely, covered in the last aspect by cartilage, and resting on the head of the metatarsal bone in the two hollows already mentioned, so as to be separated by a small interspace. They are connected by ligaments to the first bone of the great toe, as the patella is to the tibia, and glide backwards and forwards in the different motions of the joint, defending it effectually below, giving an advantageous purchase to the muscles which are fixed to them, and preserving from pressure the tendon of the long flexor, which runs between them. These bones are rarely met with in the other articulations. The motions between these bones and the metatarsus may be effected in every direction, except rotation, and are in general more limited than in the fingers. The toes, however, can be inflected backwards, or extended on the metatarsus to a greater degree than they can be bent. The advantages of this mechanism, so widely different from what we noticed in the hand, may be particularly noticed in standing on the toes, and in progression, and will be examined hereafter.

The second phalanges of the four lesser toes are so short and compressed longitudinally, as to have scarcely the usual characters of the long bones. This is a distinguishing point, in comparing them with the second phalanges of the fingers, which they otherwise resemble in miniature, giving attachments in a similar manner to flexor and extensor tendons, and to the fibrous sheaths of the former. The articulations are also analogous; the motions, which are those only of flexion and extension, are more limited.

The last, or ungual phalanges, five in number, resemble those of the fingers both in structure and formation. That of the great toe is strong and broad; the others are more than proportionably small. This last difference is the principal one between them and the fingers; the articulations and motions are very nearly the same; the latter may be a little more limited. In children they are very moveable: this mobility diminishes as we grow up, and is often completely destroyed in advanced age, owing most probably to the confinement of our shoes. The metatarsal rows have three points of ossification, the others have two, and very frequently only one.

From the assemblage of the bones we have been describing, there results a long, broad, and partly vaulted basis, for the support of the weight above, secured by numerous and

strong ligaments binding the arch beneath. The principal points of bearing are on the lower part of the heel bone; the outside of the foot in nearly its whole length; especially the posterior end of the metatarsal bone of the little toe; the anterior ends of all the metatarsal bones, and most conspicuously that of the great toe, which is proportionably strong. When the heel is elevated from the ground, the whole pressure is on these last mentioned points, and on the toes, which compensate, by their augmented breadth, their comparative want of solidity. The vaulted form gives a space in which the vessels and nerves can pass free from compression; and the number of the articulations, by distributing the shock over numerous slightly yielding surfaces, prevents the injurious effects which might otherwise arise from leaps, or falls on the feet.

*Mechanism of the lower extremities.*—In supporting the trunk, the hip bones are placed between two opposite efforts; viz. the weight of the body transmitted by the sacrum; and the resistance opposed by the limb below in the direction of the cotyloid cavity. The depressing impulse acts in a plane posterior to that of support, tending to make the hip bones move backwards on the thighs, if they were not counterbalanced by muscular efforts. The base of support, as far as regards the ossa innominata, is contained between the plane of the vertebral column behind, and that of the thigh bones in front; a space which varies in different individuals, and which is comparatively narrow in infancy, from the more oblique direction of the hip-bones, which brings the thighs more immediately under the vertebral column. As the ossa innominata become more horizontal, the base of support is rendered wider, and the muscles being at the same time more fully developed, give it additional security. This is one source of the difference in gait in manhood and infancy. Another is found in the disposition of the cotyloid cavities. As they are at a distance from the points of ossification, they are almost wholly cartilaginous for some time after birth, and therefore can offer but a feeble resistance to the thighs, quite insufficient for standing or progression, until the place of cartilage is supplied by bone. Add to this, that the two joints are comparatively nearer to each other; which circumstance, though it give facility, must necessarily diminish firmness. The greater proportional distance in the adult throws the thighs further apart above. In females this distance is greater than in the male, which gives a peculiarity to their walk, a more observable rolling of the hip in the successive advancement of each limb. This is not to be seen in the infant female, where the position and form of the hip bones differ but very little from those of the male of the same age.

The femur, which is the only bone in the thigh, is curved considerably forwards in the middle; hence a larger space is left behind for muscles; and the base of support, afforded by this bone to the trunk, is directed forwards, so that the latter is sustained in the direction, in which it has the greatest tendency to fall. The neck of the bone, besides increasing the extent of rotation, enlarges transversely the base of support; gives the body a greater firmness in standing, without impeding progression, since the head of the bone, and not the body, is the centre of motion. If the thigh bones possessed no neck, but were kept equally far apart, by increasing the distance between the cotyloid cavities, the attitude of standing would be equally secure, the transverse base of support being still the same; but progression would be impeded, as it actually is in the female, from the greater transverse diameter of the pelvis. The head of the femur, sunk into a deep cavity, is forced, in

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supporting the trunk, against the most resisting part of this cavity, viz. under the anterior spines. The strong ligamentous bands which strengthen the capsule in front and above, are so disposed as to augment the resistance to any effort of the thigh-bone in that direction, and to restrain any part of the head which may not be contained in the acetabulum. The interior ligament also adds to the firmness of the joint; preventing, by its tension, the displacement of the articular surfaces in every effort which forces the head upwards; an effort which, from the pressure of the trunk, is almost constantly operating. In the infant, the body of the bone is nearly straight, a conformation unfavourable to standing, according to the reasons above alleged: the neck is shorter, and consequently the base of support diminished; it is cartilaginous, and therefore less able to endure, for any time, an attitude which demands solidity in the sustaining parts. These are other reasons for the insecurity of the station and progression of young children, and shew by contrast the advantages of the form of the adult bone.

In the knee, we are struck with the extent of the articular surfaces, and the number and strength of the ligaments which connect them, so well adapted to sustain the weight transmitted by the thighs; the crucial ligaments limiting and maintaining the extension of the leg, preventing it from passing in this direction beyond the axis of the thigh; the patella in some measure restraining its flexion, protecting the joint, and more particularly favouring the action of the extensor muscles, which play so important a part in the functions of the lower extremity. The perpendicular direction of the leg is very advantageous in giving firmness; to this end also the immobility of the two bones which compose it seems directed. The tibia, solid and broad at either end, alone receives the pressure and continues it to the foot; the fibula serves principally to afford attachments to muscles. This disposition, so different from that observed in the analogous part of the upper extremity, bears an obvious relation to its different function. In infancy the patella is scarcely perceptible; its absence must be unfavourable to the power of the extensors, and may be one cause of the feebleness observable at that period; and further, its want is felt in kneeling.

The foot is admirably adapted to its office of sustaining every effort continued from above. It is articulated at right angles with the leg, through which it receives the weight of the body in a perpendicular direction, bearing directly on the upper surface of the astragalus, the whole length of the foot resting on the ground. The articulation is situated nearer to the posterior than to the anterior part of the feet, which gives to the base of support a greater extent forwards, a direction towards which the line of gravity naturally inclines. The lateral descent of the malleoli materially secures the firmness of the ankle joint. The breadth of the foot, increasing gradually towards the front, the length of the metatarsal bones, the direction of that which sustains the great toe, its situation and want of mobility, are other circumstances marking the distinction between the hand and foot, and adapted to increase the solidity and extent of base afforded by the latter. The functions of the foot are assisted also by its concave form, which enables it to gain a kind of hold of the bodies on which it rests, and to accommodate itself to unequal surfaces, an advantage almost destroyed by the use of shoes, but eminently conspicuous in those people whose feet are not cramped by artificial means of defence. In its posterior half nearly it rests on the ground by its outer side, composed of the solid bone of the heel, and the os cuboides, the inner side representing an

arch, and placed at a distance from the plane below; in the anterior half the weight is principally supported by the inner side, where we find the solid bones of the great toe very little assisted by the external edge.

Every thing in the structure of man evinces that he is designed by nature for the erect posture: we shall notice here those proofs only which are deducible from the framing of the extremities. One of the most obvious is the great disproportion in the respective lengths of the upper and lower limbs, and the greater comparative strength of the lower. Other marks are found in the width and direction of the hip bones, in that of the neck of the femur, in the articulation of the leg at right angles with the foot, in the size and length of the latter, and the predominance of its solid over its moveable parts. We may remark also the flattened chest, and the shoulders set off by long clavicles, so very different from the construction of these parts in quadrupeds, where the chest is compressed laterally, and the anterior extremities approach each other in front for the better support of the body. The form of the hand, and the modes of articulation between the several bones of the upper extremity, are among the numerous and evident arguments that the erect posture is natural to man, and we believe we may add, peculiar to him. In all the positions, produced by different motions, this posture is more or less preserved; so that, before we enter on progressive movements, it will be well to consider separately the simple act of supporting the body, which they necessarily include.

*Station*—or the act of standing, in man, as far as the lower extremities are concerned, will be the first point for our observation. In this attitude it is necessary that the perpendicular line, which passes through the centre of gravity of the whole body, should fall somewhere in the space intercepted between the two feet, or on the sole of the foot itself, if we are supporting ourselves on one only. This centre of gravity, when the body is erect, has been proved by Borelli to be placed between the hip bones, “inter nates et pubem,” in the human subject. To favour this disposition, we find a vertebral column curved alternately in opposite directions, and placed obliquely with regard to the direction of the ossa innominata, by which means the distribution of the soft parts is more easily managed, the balance preserved, and permanent station much facilitated. If this obliquity did not exist, and the vertebral column had been straight, it would approach too nearly the line of direction of the leg and thigh, a disproportionate quantity of the mass of the body would be placed in front of the line passing through the centre of gravity, which would continually tend to make the body fall forwards in prolonged station or progression. In the orang-outang the angle, which the vertebral column raised perpendicularly makes with the hip bones, is much more obtuse than in man, and the equilibrium is preserved by the length of the arms; the same may be observed of the gibbon, the simia lar of Linnæus. In quadrupeds this angle, under similar circumstances, is still more obtuse, and the efforts they make to remain upright on the hinder feet are continued with difficulty, more especially if not assisted by some other peculiar advantages of construction, as in the bear, for instance, by the length of the heel. In man, the hip bones united to the sacrum form a circular support, by means of which the columns below are not inclined to the trunk, but sustain it in perpendicular lines. If they had converged above, they would have formed an angular support, not so capable of resisting the pressure, and requiring a constant and powerful exertion on the part of the adductor muscles. As it is, the columns are pressed on perpendicularly by the transverse width of the hip bones,

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so that the pressure may be said to render them more firm and steady. The long bones of the lower extremity in man are placed nearly vertically on each other, and on the foot. And we may just remark, that even in station a succession of columns of the same size is probably more advantageous than a single one, equal in bulk and length to the whole: this has been demonstrated in the case where the weight is upheld by columns supposed to be flexible. The direction of the head and neck of the femur has been already mentioned as increasing the base of support, and we may add that the oblique position of the latter decomposes, in some measure, the pressure of the trunk from above, and renders it less sensible than if it had been vertical; avoiding at the same time the disadvantages arising from an inclined position of the whole column, as mentioned above. By the arch of the necks also the thigh bones are projected from under the hips, and sustain the trunk with greater constancy and freedom than if they had been placed vertically beneath it during its different inclinations. The thighs, charged with the whole weight above, transmit it to the leg at the knee joint; somewhat differently, however, in the adult, and in the aged. In the latter the spine is bent forwards, and to preserve the balance the thighs are necessarily also bent, and press obliquely on the leg, a disadvantageous bearing, as requiring greater muscular efforts, and soon becoming on this account wearisome. It is through the tibia alone that the pressure is communicated to the foot, which finally supports the whole weight. The arch of the latter is favourable to station only inasmuch as it favours the adaptation of the sole to inequalities of surface. In progression it may give ease and grace, but the long and somewhat flattened foot is probably best suited to firmness of station. The concavity is lessened by the pressure, which acts most sensibly on the anterior and more moveable part: it is very evident, when the foot comes with force to the ground, and it may be proved also by the aching and uneasiness produced by wearing short shoes, which impede the elongation of the foot. A question has arisen concerning the most advantageous base of support, or what opening between the two feet is best suited to security of station. An answer equally applicable to every case cannot readily be found; the nearer it approaches a square, including the feet, the better. Still different individuals must require different bases as suited to their own form. In every case, if the separation be too wide, the limbs lose their perpendicular bearing, and become inclined to the trunk. The smaller the angle made by two lines produced backwards in the direction of the feet, the better: it seems, indeed, that a parallel direction of the two feet is the most natural, as we see it in children and in the greatest number of adults, especially of those who have not been instructed by art. The body has a tendency to fall forwards, which is partly counteracted by the length of the foot; increasing the base of support in the anterior direction. Now if the foot be turned much outwards, the base is necessarily shortened towards the front; and, as in station, the trunk has no disposition to fall laterally, what the base gains in that direction is in no degree equivalent to what is taken away from the other. The same observation applies to turning the toes inwards; but as this never takes place to any considerable degree, an abuse of it is less to be apprehended. The unnatural position, in which education teaches us to place our feet, with the heels forming an obtuse angle behind, is contrary to the whole mechanism of the limbs, is uneasy, and insecure. In different gymnastic exercises the feet are placed so as to offer the greatest possible resistance to the probable direction of the effort they will have to withstand. In wrestling, where the force in

the first instance is generally applied laterally, we observe the feet parallel, and at a considerable distance from each other. Constant attention, however, is absolutely necessary to change this base, if any unexpected impulse be made in a contrary line. A deficiency in this respect is the reason why inexperienced wrestlers are so readily pulled down forwards, or thrown on their backs, their exertions being uniformly directed to oppose the expected ones of their adversaries; if these be suddenly altered, there is no adequate power of resistance. In boxing, the base is increased from before backwards, the feet are placed nearly at right angles and far apart, the knees are bent a little, and the trunk lowered. Here the impulse is expected in front, and the attention is particularly directed to oppose it in that point. This, in short, is one of the great principles observed not only in these exercises, but in every laborious exertion, as in pushing or pulling, where the line of opposition does not vary. Whatever be the direction or distance of the feet from each other, no muscular effort can prevent the fall of the body, whenever the perpendicular line from the centre of gravity falls without the quadrilateral space intercepted between the feet. And a man can support a weight much heavier than himself, provided that the line from the centre of gravity of such body fall within the base of support.

Our observations hitherto are principally applicable to station, with the trunk erect. Let us now suppose the feet fixed securely on the ground, and the trunk moving in different directions by means of the articulations of the hip with the thigh-bones. In bending forwards, if the motion be prolonged considerably, the centre of gravity is no longer supported, and a fall is the immediate and necessary consequence. We have before remarked, that the articulation of the sacrum with the ossa innominata is in a plane posterior to that of the feet. Now, if in bending forwards, the hip-bones move on the thighs, so as to bring the two bases into the same plane, the centre of gravity is easily thrown forwards beyond them, and a fall is the result. To counteract this, when the trunk is bent much forwards, we at the same time carry the upper part of the lower extremities backwards, the feet remain advanced, the leg and thigh are inclined backwards, so as to form an angle with the body. In extending the body on the thighs, and carrying it back beyond the perpendicular, as there is no extended base of support behind, analogous to that formed by the feet in front, we are obliged to bend the knees, in order to bring the centre of gravity within the space occupied by the feet. If the lower extremities are maintained in an upright position, while the trunk passes behind the perpendicular line, a fall is inevitable. Lateral inclinations of the trunk on the thighs are necessarily confined; since, in order to lower it on one side, the opposite limb must be proportionably raised; when both feet touch the ground, it is almost completely prevented, so that the lateral balance is seldom lost, especially as we can at pleasure widen the base of support.

The power of standing on the toes results from the mode of their articulation with the metatarsus, which allows of extension or inflection upwards, beyond the axis of the latter. By this mechanism we rest on the whole length of the toes, not merely on their points, which would be utterly incapable of supporting the weight; here too the sesamoid bones are essentially useful, the pressure bearing directly on them, as it does on the patella in kneeling. In this attitude the feet are extended on the leg, and form an obtuse angle with the toes, which constitute the basis of support; the legs and thighs are in the same straight line, and the trunk is projected a little forwards by the elevation, so that the centre of

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gravity is brought over the contracted plane, which now forms the base of support, lessened very much in length posteriorly by the loss of the tarsus and metatarsus. The same difficulties occur if we stand on any pointed, or narrow body, and for the same reason, *viz.* the diminution of the space in which the vertical line from the centre of gravity must fall, in order to preserve the equilibrium. This applies also, and more forcibly, to the cases in which we stand on the toes, or heel of one foot only. In the last instance the foot is bent, the sole elevated, the rounded heel alone touches the ground by a very limited surface, great muscular exertion is required to keep the line of gravity vertical, the body vibrates on every side, and the attitude is necessarily soon lost or discontinued. We have not so much difficulty in standing on the heels of both feet, though this is far less easy than on the toes, on account of the points on which the weight rests. Standing on a single foot, with the whole sole on the ground, is an attitude more easily maintained, on account of the greater length of contact, and the less muscular exertion necessary to insert or erect the trunk so as to bring the line of gravity within it. In this position the body is more or less inclined on the limb which supports it, and may be moved with facility in every direction by means of the joint at the hip. The long neck of the thigh-bone is here eminently useful, by widening the base of support afforded above to the trunk; and the position cannot for an instant be maintained by animals, who, besides other obstacles, have a very short neck to the femur. It is obvious that station on one foot must be more difficult than on two, as in the last case it is not only the feet, but the plane intercepted by them, which form the base, and much less exertion is required to keep the line from the centre of gravity within it. We must have observed also, that when in station on one foot, the trunk is much inclined in any direction, we throw out the other limb in the opposite one, in order to keep the centre of gravity vertical to the base: and if we stand on the toes or heel of one foot, not only the other leg, but the arms also, are called into action to preserve the equilibrium, which is perpetually lost and regained by the tottering trunk, and shuffling base. A fixed stability is utterly prevented by the difficulty of keeping the balance even under the greatest muscular exertions.

In sitting, the support is afforded by the tuberosities of the ischia, the thighs and the interval between them, and by the legs also, if we sit on the ground with them extended. This is a firm position, easily continued, especially if the body is inclined a little forwards over the base; if it is inclined backwards a fall may easily take place. On this account we have generally backs to our seats, to allow the trunk to recline, when the muscles are fatigued by supporting it in its position of inclination forwards. The legs and thighs are concerned only in a secondary way in this posture, as the principal support is afforded by the tuberosities of the ischia resting immediately on the surface below.

Kneeling is another attitude in which the lower extremities are employed, but the base of support is extended posteriorly, consisting of the space included by the legs, which are projected backwards under the trunk. Hence the body, if erect, is disposed to fall forwards; we require a resting place in front, as we throw the hips backwards, to bring the line of gravity over the legs. This posture is far from an easy one, since it requires a constant and unfavourable exertion of muscular force. The use of the patella has been already explained.

The importance of the general law, by which it is necessary that a vertical line passing through the centre of gra-

vity should fall on some point within the base of support, is strikingly exemplified by the following observations. If we stand with our back and feet touching a wall, and then make a profound bow forwards, we inevitably fall, as the vertical line from the centre of gravity soon over-reaches the base of support. Again, when sitting with the trunk and legs perpendicular to an horizontal plane, we cannot rise from our seat; because the centre of gravity of the trunk falls far behind the feet: we are obliged consequently either to incline the trunk very much forwards, or draw the feet backwards under it, in the first case changing the centre of gravity, in the latter the base of support; and then by muscular efforts the thighs are easily extended on the legs, the trunk suspended, and the whole body erected; operations extremely difficult, if not impossible, supposing the original position had been preserved. Our notions of station would be very imperfect if we did not take muscular exertions into the account; it is in vain that we place a dead body so as to bring the centre of gravity over the base of support; the bony columns are no longer regulated by the varied efforts of numerous muscles, as in the living subject; the machine is incomplete, and instantly gives way to the pressure. The same phenomena occur if fainting comes on in the erect posture; the head and neck incline forwards, as also the trunk; the bones bend on the thighs, the latter on the legs, and these again on the feet. We must not therefore confine our attention to the idea of bony columns pressing vertically on each other, but recollect that they have highly moveable articulations, which require some strong external efforts to give them positive stability. These exertions are more or less powerful as the bones depart more or less from a vertical bearing on each other. Hence the anterior extremities of quadrupeds possess fewer and less powerful muscles than the posterior: as, in the first instance, the bones are directly extended on each other, and press vertically on the ground; in the last, they form angles more or less open, which can be preserved only by a constant exertion of muscular force. The elephant is an illustrative exception to this observation; his hind limbs are nearly vertical columns; a mechanism which diminishes the quantity of muscle otherwise necessary to support his enormous bulk. In insects, on the other hand, the joints are bent at very acute angles; a structure less inconvenient than we might at first suppose, as on account of the smallness of their body, the weight is diminished in a sub-duplicate ratio to their size. In birds who sleep perched on trees there is a peculiar construction, by which the mere cessation of muscular action, the allowing the body to sink, and the knees to bend, induces a mechanical contraction of the toes, which grasp firmly the body on which they rest, and secure their position when at rest. In the grallæ tribe, in the stork for instance, who stands motionless for hours waiting for his prey, there is a particular construction in the articulation of the knee, which enables him to stand without much muscular exertion.

*Progression*—may be effected in many different ways, of which we shall examine only the most ordinary and simple. In walking, the action, which carries the body forwards, backwards, or to either side, consists in alternate motions of the lower extremities, in which each of them becomes, in its turn, the fixed point on which the whole weight of the body is supported; the limb which moves, giving in its elevation an impulse to the trunk by means of the hip bone. Each of these motions is called a step, and a sustained succession of them constitutes progression: and in order to understand the latter, we shall examine the mechanism of the step under different conditions. In walking, if we suppose both

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Both feet to be on the same transverse line, the limb (say the left) which makes the first step, is raised from the ground and advanced, by bending the hip joint; it is then extended, and lastly, the foot preserving its advanced position, is fixed on a different spot; so that the centre of gravity of the body which, during the advance of the left leg, was sustained by the right, is moved forwards by a simultaneous movement of the trunk; and the line of gravity falls between the two feet. If the step is short, the hip and trunk move but little; if it be long, and the left leg carried far beyond the right, there is an evident rotation of the right hip, and consequently of the trunk on the corresponding thigh. By this horizontal rotation, which carries the left side of the body obliquely onwards, the extent of the step is greater than it would have been by the simple bending the thigh; and we see it in fact most evidently in long strides, where the rotation is so great, as to bring the shoulder of the advanced side immediately in front, the hip moving through the quarter of a circle, giving thereby an additional impulse to the limb below. As the step is shorter, this lateral rotation is less observable, till in some cases it can be no longer noticed. It is more evident in the female, from the greater transverse diameter of the pelvis; and is particularly striking in individuals who have a stiff, or ankylosed hip joint, where the limb cannot be advanced by bending the thigh. The short step is effected, on the contrary, chiefly by the alternate flexions and extensions of the joints of one extremity, uninfluenced by any movement of the trunk on the other.

If the feet are not in the same transverse line at the commencement, the limb, which is behind, and inclined to the trunk, is the one to be moved forwards. Here the foot rises, each part quitting the ground successively, from the heel to the toes, by a kind of circular motion. The limb is thus elevated and advanced, and the centre of gravity is carried in the same direction, which latter is effected with greater facility, as the body at the same time leans a little forwards. When this impulse is carried to its full extent, the toes are detached from the ground by the thigh being suddenly bent on the hip, which has been moved forwards, and the limb is carried on as in the former case, the other remaining fixed as the temporary support. The hip and knee joints are then extended, and the foot bent on the leg. The foot touches the ground first by the heel: this is succeeded by a circular motion of the anterior part of the foot round this fixed point, and a corresponding motion of the leg in the same direction, which brings it to a vertical line at the time that the toes begin to bear on the plane below. In these circular motions the foot is sensibly elongated, and its concavity lessened by the pressure, its vaulted form, and the number and mode of its articulations imparting a degree of ease and grace to the whole motion which we look for in vain, where the foot is flat and stiff, and the whole sole quits, or reaches the ground at the same instant. There is, in this case, an awkwardness of gait, and a real inability of walking with promptitude and vigour. This step we have been describing takes place successively in each limb in progression; and differs from the preceding in being more extensive, and depending more importantly on the foot. The impulse which its elevation communicates to the trunk will be influenced however materially by the knee: if this is bent in proportion as the foot rises, the limb loses in one action what it gains by another; the impulse will be stronger as the knee is kept more extended. And when the foot is detached at once, without this rotation, no impulse will be given to the hip by the limb in motion: if the pelvis roll on the thigh which is fixed, it must be by an independent

muscular action, as in the former case. In every case, as soon as the foot has left the ground, the trunk supports the limbs; and carries it forwards. The mechanism of the step backwards will be easily understood from what has been said: we observe only that the foot is raised more immediately by bending the knee; and that when the step is prolonged, there is an evident horizontal rotation of the trunk in the same direction. The side step is produced by gently bending the knee to detach the foot from the ground, and then abducting the thigh; or by lifting the whole limb by a lateral inclination of the trunk on the opposite one, and then separating them, the knee being all the while extended.

Walking is a succession of these motions, and requires for its regularity an equal length of both limbs; a shortness of either limb induces a sinking and relative inclination of the whole trunk to the corresponding side, every time that the deficient extremity touches the ground. In the most natural mode of walking, one foot does not quit the ground entirely, until the other touches it wholly, or in a great part of its length: the latter begins to fix itself while the former still rests on its point; the vertical line from the centre of gravity, which fell on one foot during the transportation of the other, being carried forward, and dropping at this time between the two. When the advanced foot is firmly fixed, we throw on it the centre of gravity; the same motion necessarily projects the whole body forwards, and a succession of similar phenomena takes place. At each step the impulse given to the trunk by the limb which has just quitted the ground produces an undulatory motion up and down, and at the same time an horizontal rotation alternating from one side to the other. It is the latter which, from not being sustained equally, produces the deviation from the straight line in walking forwards; so constantly observed if we walk blind folded, where consequently we cannot correct incidental errors by the sight. The best chance of walking straight in this case is by taking very short steps, and for the reasons insisted on above. In fact, the centre of gravity is not, when we carefully endeavour to attain it, moved forward in the same straight line, but varies more or less between the lines described by the feet at every step, in a degree proportionate to the extent of each. This is scarcely noticed, but is evident from this simple experiment. If we stand at any distance from a small perpendicular rod, and fix our eyes on any point some way behind it, and in the same straight line, we shall, as we advance to the rod, find this point alternately to the right and left of it, as we move each limb. A proof that the trunk is not carried as in a straight line, but describes a tortuous one, winding from one side to the other. Another consequence of this rolling of the trunk on the opposite limbs in succession, is a swinging motion communicated to the upper extremities: these move, most commonly, in an opposite way to the feet; that is, the right arm moves on at the same instant that the left leg propels the trunk. The use of this cross motion of the arms is supposed to be that of correcting the lateral impulse given to the trunk by the leg in its elevation. In every case of progression there must be a regulated degree of flexions and extensions, which is in some instances provided for by the mechanism of the bones, and their ligaments, but in all depends principally on an uniform succession of sustained muscular actions. The greater difficulty and fatigue experienced in walking up an ascending plane depends upon the greater degree of flexion necessary to raise the limb from the ground; this must be increased as the plane becomes more vertical; the heel is at the same time lower than the toes, and must pass through

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more space in each elevation than in the ordinary case of walking on plain ground. Walking down hill is for the same reasons less difficult; there is less occasion for extensive muscular action. The object is to regulate the impulse which the trunk easily acquires, and to keep the centre of gravity over the feet, by throwing the trunk a little backwards, instead of leaning forwards, as in the preceding case. In ascending also we have each time to elevate the weight of the body by muscular powers; in descending we have only to prevent it from sinking too fast. Mounting steps, or a ladder, or descending either, are still more difficult, as the reasons above given apply more strongly.

Running differs from walking chiefly in the rapidity and force with which the motions of the lower extremities are executed. The mechanism by which they are produced is nearly similar; the remarkable differences are, that the toes only touch the ground, and the whole trunk is inclined very considerably forwards. In consequence of the first circumstance, a small surface only is in contact with the ground; and this can be more rapidly applied and detached, while the extension of the foot upon the leg adds to the length of the limb. From this small extent of the base of support arise the frequent falls in running from trifling obstacles, or slight lateral impulses; and hence, in this mode of progression, we should constantly endeavour to preserve the balance, by preventing the centre of gravity from being removed too quickly from the leg behind, or from being thrown too soon on the one in advance. Running is also insecure from the short time allowed for fixing the point of support; and hence positive stability is lessened inversely as the necessity for it is increased by the quick transition of the centre of gravity from point to point. At each step the trunk is suddenly and violently carried forwards by the limb which has just left the ground, and which must be immediately and considerably advanced to support the centre of gravity. In running very fast, especially on a declivity, so powerful an impulse is communicated to the trunk, that it is almost impossible to stop suddenly; we gradually slacken our pace, still projecting the limbs to support the trunk till the impulse is weakened. In running up an acclivity we always bend forwards, to assist the propulsion of the centre of gravity, which is effected under many disadvantages; we generally do so in running on plain ground, though, when we run carefully, the head and shoulders are thrown back to counterbalance the impulse below. When from fear, or inability to continue the muscular exertions necessary to maintain this posture, the trunk is neither thrown back, nor even kept vertical to the horizon, the runner appears to yield entirely to the impulse, to commit himself almost to chance; his only endeavours being to throw his legs out rapidly and to the greatest extent, to sustain the increasing velocity with which the centre of gravity is carried onward: the ground covered at each step is really immense, the power of balancing is totally lost, and the slightest inequality of surface is sufficient to overturn him with the roughest violence. If he is steady enough to reach the bottom in safety, he continues his course a very considerable way before the impulse is destroyed, and the power of regulating his movements recovered. In running, the lateral rotation of the hip and trunk on the thigh is extensive, from the length of the steps; and the same cause produces an equally great and rapid motion of the opposite arm to preserve the equilibrium, which is more easily lost than in walking.

In leaping, the body may be raised vertically, or with any degree of obliquity. The joints of the lower extremities are first closely bent, and then suddenly extended, so as to propel the trunk; for the ground effectually resists the

impulse, which must be entirely spent on the moveable parts above. The alternate angles, formed by the ankles, knees, and hips, depress the centre of gravity, without altering its bearing on the feet; and the same mechanism enables us to elevate the trunk nearly in a vertical line, the circular motions in opposite directions executed with almost instantaneous velocity, acting in a straight line intermediate to them all. If the flexions were all made in the same direction, subsequent extension would be more laborious, and a perpendicular impulse, such as produces the vertical leap, would be impossible. The mechanism of leaping may be illustrated by comparing it with other motions. The muscular powers being the same, the leap will be more considerable as the levers are longer, and more inclined on each other. Hence animals, whose hind limbs appear disproportionately long, can make the most extensive bounds; we need scarcely instance the kangaroo, hare, squirrel, or grasshopper.

The elevation of the body in a vertical leap is continued so long as the communicated impulse exceeds the power of gravitation; as the former diminishes, the latter again begins to operate, and the body descends in the same line with that in which it had been elevated. It is incapable, while in the air, of altering the general direction derived from the first impulse; although many motions of the extremities may be produced, as we observe in dancing. The ground, from its want of elasticity, communicates no impulse to the body at the moment of elevation. A certain resistance to the action of the muscles on the moveable levers is required. If the ground be soft or sandy, it yields too readily to the impulse of the feet, and leaping is impeded: on the contrary, if the point from which the jumper springs be elastic, as in the case of a flexible board, or a tight rope, there is an evident re-action, considerably increasing the impulse communicated by the exertion of the lower limbs. In jumping forwards the trunk is inclined, and projected in the same direction by the extension of the thigh on the leg. This latter motion is counterpoised or varied, according to circumstances; but it is so essential in every case, that we cannot leap if the knees are kept extended, no muscular action or exertion could then raise the body from the ground. The chief effort is to turn the thigh and trunk balanced on it forwards on the tibia; and the impulse thus given predominates over the others; in leaping backwards, the tibia is the more moveable division of the lever by a variation in the combined action of the muscles employed, determinable by the will. In the vertical leap the body moves up and down in the same line: but if the impulse is given in a line inclined to the horizon at oblique angles, the line described by the centre of gravity will be a parabolic curve, compounded of the uniform straight motion of projection, and the force of gravity, as in other projectiles. While the first predominates over the last, the body ascends; when they are in equal power, the elevation is the greatest; from this point, it descends, the force of gravity acting with increasing effect as the impulse is weakened. The impulse, in this case, may be considerably increased by a previous motion given to the body by running: the impetus is somewhat altered in direction by the violent extension of the extremities, but it acts with almost undiminished force in projecting the body: there are here two causes acting in opposition to gravitation. This kind of leap is facilitated by inclining the body forwards; and, in order to afford a point of support to the centre of gravity, we always find, before the body is elevated from the ground, that one of the legs, generally the right, is much before the other; this position is preserved throughout, for the same reason, or the two legs are brought into parallel obliquely inclined lines, before we reach the ground

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ground at the end of the leap. If we jump with the feet together, we cannot incline the body much forwards, without losing the balance. In this case, to assist the impulse, we swing the arms backwards and forwards before we make the spring, endeavouring to give some degree of horizontal impetus to the trunk, which must however always be inferior to that obtained by even a short run. The body comes in contact with the ground, at the end of the leap, impressed by a double force, *viz.*; the projectile impetus, and that acquired by gravitation in the descent. We extend the feet on the legs, so as to touch the ground first by the toes; we then yield somewhat to the force, and allow the joints to be bent gradually, so as to weaken and finally destroy the shock. In order to destroy the impulse given to the centre of gravity, we throw back the head and shoulders, and slacken our pace by degrees, till the power of balancing is restored.

The action of dancing, which consists in a rapid change, in various manners and directions, of the lower extremities, principally resembles, in some respects, the *run*, in many others the *leap*. We omit the detail of those extraordinary and amazing feats of agility, which astonish us in the stage dancer, or the tumbler; as they depend, not on any peculiarity of mechanism, but on the powerful, long sustained, or rapid actions of muscles, educated to the task, and preserved by constant exercise in the highest possible state of energy. Hopping is a succession of leaps on one leg only; the actions are otherwise analogous. Skating is a simple motion; the mechanism of which may be readily conceived after the observations we have made: the centre of gravity is brought alternately over the opposite feet, as each glides on the plane beneath, and the balance is preserved by muscular action. Swimming is a more compound action of both upper and lower extremities, involving in its discussion many interesting questions, independent of their functions, and which consequently cannot properly be considered here.

For more detailed information on the subject of animal mechanics, we refer the reader to Borelli, de Motu Animalium; Haller, Element. Physiol. tom. iv.; Barthéz, Nouvelle Mécanique de l'Homme: see Jour. des Scavans 1782-1783. Bichat, Anatomie Descriptive, tom. i. Cuvier, Leçons d'Anatomie comparée; tom. i. sur la fin. There is a catalogue of authors on this subject in Dr. Young's Natural Philosophy v. ii. p. 164.

*Comparison of the upper and lower extremities.*—A review of the differences in the construction of the upper and lower limbs will illustrate the mechanism of their component parts. There is a general resemblance of form throughout; and the essential varieties may be all referred to the principle of mobility in the upper, and to that of firmness in the lower. In man, the extremities are nearly parallel to the long diameter of the trunk; and consequently they must be parallel to each other; but they are not in the same vertical plane. A line drawn from the glenoid cavity of the scapula to the acetabulum, will be very oblique from above downwards and forwards, because the plane in which the former lies is posterior to that in which the latter is found. Hence the arm drops necessarily behind the thigh. The advantage of such a disposition in the upper extremities is, that the principal motions, which are those in the anterior direction, have a greater range than if the glenoid cavity had been seated nearer to the front of the trunk. The extremities differ also in the space, by which they are separated from each other. If we judged only by the intervals between the right and left glenoid and cotyloid cavities respectively, we should suppose the difference to be great;

the long clavicles keeping the first at a greater distance than the pubal portions of the hip bones do the second. This, however, is compensated by the length and obliquity of the necks of the thigh bones, which throw the axes of these bones far without the cotyloid cavities. We have here supposed the legs to be extended, and the arms lying in their natural direction by the sides of the trunk; if the knee and elbow be bent in this position, we shall find the angles are open in nearly opposite directions, that of the knee backwards, and the elbow forwards. These are the only joints in which the articulations are directly inverse in their modes of action; in quadrupeds, this condition prevails from the shoulder and hip to the feet in a very striking manner. The lower extremities are nearer together below than above; while the upper are kept asunder by the intervening body. The lower extremities are rather longer than the upper, in consequence of the great length of the thigh and leg, when compared with the arm and fore arm. For the latter, by the long axis of the hand being in the same line with their length, gain much more than the lower extremity does by the mere thickness of the foot. When the arm hangs easily extended by the side, the points of the fingers reach to about the middle of the thigh; yet there are many varieties in this respect. The solid form, and the broad articular surfaces of the lower, are strikingly contrasted with the slender make and narrow articulations of the upper; the first bearing a marked relation to their principal function of sustaining the body, the latter to their distinguishing character of mobility. At the time of birth the upper extremities are more advanced in formation than the lower. This feature is, however, more remarkable, the nearer we mount to the first development of the embryo; it is gradually lost after birth, and the structure of both is completed nearly about the same period. The different nature of their functions, those of the upper commencing almost immediately, and those of the lower not until a considerable interval after the birth of the child, explains easily the reason of this disposition.

The bones of the hip and shoulder differ more in their form and connections than any other parts of the extremities. The scapulæ are sustained by muscles, allowing a great variety of motion, and are kept apart by the two moveable clavicles in front; the hip bones are bound firmly to the spine, and the articular cavities separated from each other by an immoveable medium. The space between the cotyloid cavities is proportionably greater in the female than in the male. The same excess may be observed in the shoulders, where it arises from the greater comparative length of the clavicle. The breadth of the scapulæ increases in the male the transverse diameter of the shoulders, which on this account is particularly striking from behind; in front they are not proportionably so wide as in the female. It is therefore the proportional excess of width in the hips, and not any decrease in the breadth of the shoulders, which gives to the female figure one of its most prominent features; this distinguishes it from the male, in whom the strong, though narrow, hips are opposed to the comparatively spreading shoulders. These circumstances are sufficiently evident in examining the disposition of the bones; but they become still more striking, by the addition of the soft parts, in the complete subject, where the strongly marked and muscular form of the shoulders, and the contracted outline of the hips in the male, is finely contrasted with the delicacy of the first, and the swelling roundness of the last in the female. The hip bone exceeds the scapula and clavicle in volume, as well as in the firmness of its articulation; it further gives a fixed point of motion to the thigh, by a  
deep

deep articular cavity, whereas the scapula offers a shallow and easily moveable one, yielding to a slight impulse.

The femur exceeds the humerus very much in size, and length, (this last being nearly in the ratio of 46 to 33,) and in the extent of its articular surfaces. Although their motions are for the most part analogous, some differences may be pointed out. The movements of circumduction and rotation exist in an inverse ratio to each other. In the thigh bone, the length of the neck, which is the lever of rotation, gives great extent to this motion, and thus supplies the want in the leg of the motions corresponding to the pronation and supination of the fore-arm, so that all rolling of the foot out and in, when the limb is extended, arises from a motion of the whole limb. The short neck of the humerus, on the contrary, by bringing the axis of the bone nearer the centre of motion, limits rotation; which is less essential, inasmuch as the hand is moved by the pronation and supination of the fore-arm. Circumduction is more confined in the thigh by this very length of the neck, which makes an angular lever of this bone, differing much from the nearly rectilinear one of the humerus. In the first case the axis of motion is not in the long axis of the bone; in the last, it is nearly so; and the difficulty of this motion is proportional to the difference between the two axes, while its facility is greater as they approach each other more nearly. The advantages of this disposition, in giving mobility to the upper, and firmness to the lower extremities, may be readily perceived.

The leg exceeds the fore-arm in the size and length of the bones, the proportions being as 39 to 26. In the orang-outang the ratio of the thigh to the arm is as 9 to 10, and that of the fore-arm to the leg as 9 to 11; which proportions are very different from those of the human subject. The excess of length in the lower extremity of man is seen most evidently when he attempts to move on all fours, as we express it. To correct this disproportion he is obliged to bend the joints of the lower extremities, or to throw them out very obliquely behind the trunk, whilst the upper are perpendicular to it. The leg and fore-arm resemble each other less than the thigh and arm; in the fore-arm the parts are arranged favourably to mobility; in the leg the object is to procure a firm and solid support, which can transport the centre of gravity with ease and safety from one point to another. Of the two bones of the fore-arm, which are nearly equal in every respect, one rolls easily over the other, and the hand is articulated with the moveable bone. In the lower extremity these rolling motions would have been dangerous; to give it firmness, the foot is articulated with the tibia, which corresponds to the ulna, and not with the fibula; the latter possesses no perceptible power of motion.

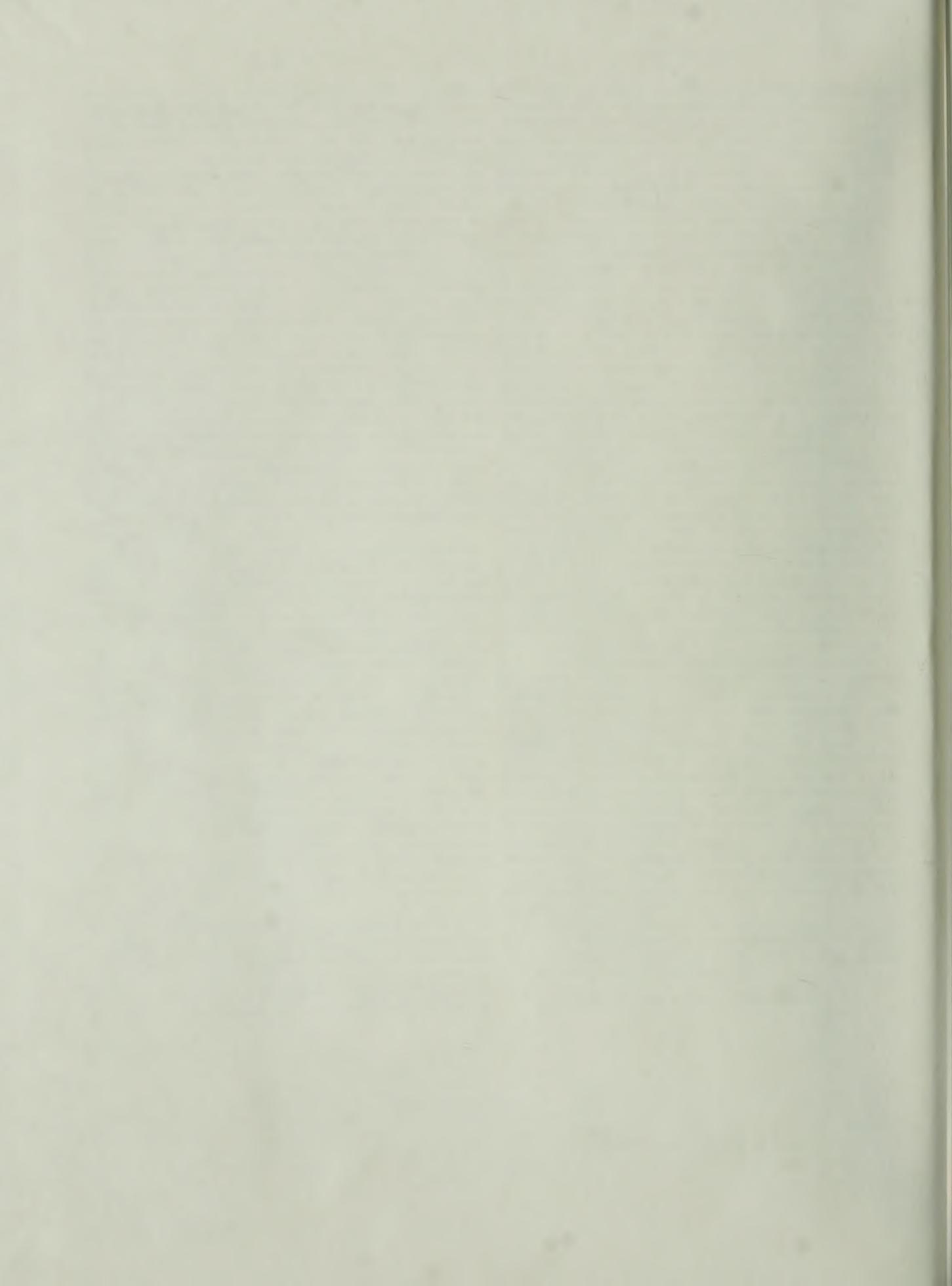
The hand and foot resemble each other most closely in the structure and number of the phalanges, and of the bones which support them; the principal differences occur in the carpus and tarsus, which are the most solid portions. That part of the hand in which its strength resides is less developed, and has far less volume than the analogous parts

of the foot, on which the whole weight of the body in station finally rests. The moveable phalanges, which are the principal agents in executing the functions of the hand, are much longer, and larger than those of the toes, which are not so essential to station or progression. The foot and hand are disposed inversely as to form; the posterior part of the former, and the anterior part of the latter, is the most important, the longest, and possesses the most striking characters. The functions of the hand render it necessary that its plane should be nearly continuous with that of the fore-arm; otherwise the radius could not guide it so precisely over the objects in view. In the foot, the articulation is so disposed that its posterior part offers a powerful lever for muscular agents, and a solid support for the mass above; it is formed by a single bone of the foot, which necessarily adds to its solidity. The metacarpus and metatarsus have a much greater similarity to each other; the latter is the more solid, and offers this principal difference. The metatarsal bone of the great toe, by far the strongest of the whole, has scarcely any motion on the tarsus, and is on the same plane with the others; while that which supports the thumb has a very considerable extent of motion, and is anterior to the rest. This arises from the obliquity in the articulating facet of the trapezium, which is directly transverse in the first cuneiform bone of the tarsus. Further, this bone in the foot is not separated from the other metatarsal bones, by an interosseous space larger than that between all the rest, as is the case with the metacarpal bone of the thumb. These remarkable differences depend wholly on the solidity necessary for station, and the great mobility required for the important offices executed by the thumb in the human subject. In the ape tribe, the great toe on the contrary may be properly regarded as another thumb in its structure and uses. The toes can be inflected further on the back of the foot than the fingers can be on the hand, a disposition which is accommodated to progression, especially to running swiftly; an analogous effect is produced in the hand by the inflection of the carpus backwards on the fore-arm. At the time of birth the important parts of the hand are already well developed; the metacarpus, and more especially the fingers, are sufficiently formed for the infant to seize objects within its reach, and to distinguish some of their qualities. This early development of the organs of touch would seem to bear a marked relation to the corresponding advancement in the formation of two other organs of sense, the eye and ear, they being all associated closely in confirming, or correcting external sensations. The important part of the foot, the tarsus, is far behind in formation, as it is not called into use till some time after birth, till the organs of sense have long been exercised in common, and can now mutually assist each other.

Respecting this comparison between the upper and lower limbs, see Vicq D'azyr sur la comparaison des extrémités entr'elles dans l'homme, et dans les quadrupèdes, in the Histoire de l'Acad. des Sciences 1774.

EXTREMUM *Claudit Diem.* See DIEM.





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